1. GENERAL INFORMATION

00. INTRODUCTION

The F27 is a short to medium haul twin turboprop aircraft.
The design specifications called for good overall performance on economy and safety coupled with general simplicity and ease of operation and maintenance.

The structural system is based on laminated bonded configurations, which give to the airframe a long fatigue life combined with fail-safe factors and which give alternative stress paths should cracking or delamination occur.

The cockpit, passenger- and cargo compartments are pressurized.

The F27 has the following basic systems:

- Power plant

  Aircraft propulsion is provided by two Rolls-Royce Dart RDa-7 engines which drive through a reduction gearing the double-stop four-bladed propellers. The engine-driven accessories are mounted on a separate accessory gearbox which is driven by the engine through a drive shaft.

- Fuel system

  The fuel system has two fuel tanks which are integral with the wing structure (additional fuel storage provisions are available on customer request). Each fuel tank supplies its relevant engine, cross-feed facilities are also incorporated. Pressure refuelling is via an adaptor in the RH nacelle. Gravity filling can be done via two overwing caps.

- Electrical system

  Electrical power is generated by two engine-driven 28-V DC generators. 115 V AC, 400 Hz is supplied by inverters. For engine starting and emergency supply two batteries are installed. For heating and de-icing purposes two engine-driven 208-V alternators are installed.

- Pneumatic system

  Pneumatic pressure is supplied by two engine-driven compressors and is used to operate the landing gear, normal brakes, alternate brakes and nose wheel steering.

- Flight controls system

  The primary flight controls are operated by push-pull rods and lockclad cables with tension regulators. For flaps operation and aileron trim electrical power is used, but emergency flap operation can be done manually.

- Air conditioning and pressurization system

  Cabin air is supplied by two engine-driven blowers. The temperature is controlled in conjunction with a cooling turbine. Two outflow valves control the cabin air outflow for ventilation and for maintaining a differential pressure of up to 4.16 psi.

- Ice and rain protection systems

  Wing and tail de-icing is accomplished by inflatable de-icing boots, integral with the leading edge structure. Air for inflation is bled from the engine compressors.
  For engine air-intakes, propellers and windshields, resistance-type elements supplied by electrical power from the alternators is used.

- Fire protection systems

  Engine fire is indicated in the cockpit by fire warning lights and a bell. The fire extinguisher bottles are in the engine nacelles.

- Oxygen system

  The crew oxygen system is used in case of cabin decompression or when there is smoke in the cockpit.

- Doors (Mk600)

  An outwards and upwards opening large cargo door is installed at the LH forward side of the fuselage. It is electrically operated. The cargo door incorporates an outward-opening crew door.
  At the rear, LH side, a manually-operated passenger door is installed. The door opens inwards and can be slided rearwards.
  At the rear, RH side, an emergency exit door is installed in the toilet compartment. The door opens inwards.

Aircraft serial number

Each aircraft is numbered in accordance to the sequence of production beginning at number 10100.
The serial number is on the aircraft data plate, located at the LH side of the cockpit entrance on the pneumatic compartment wall.

Aircraft mark number

Mark - Number used for identifying variations in the aircraft:

100 - Friendship interior, small door and Dart 6 engines
200 - As Mark 100 but with Dart 7 engines
300 - Combi interior (metal floor in cabin), large cargo door and Dart 6 engines
400 - As Mark 300 but with Dart 7 engines
500 - As Mark 600 but with extended fuselage
600 - As Mark 200 but with large cargo door
700 - As Mark 100 but with large cargo door

Mark code - Code used for identifying variations in the aircraft mark:

C - with combi interior. Large cargo door in front fuselage with a passenger door in rear fuselage
F - with small crew door. Passenger door in rear fuselage
MAR - Maritime aircraft
M - Troopship. This aircraft has two wide doors in the rear fuselage for paratroop dropping
P - Retrospectively equipped with a large cargo door
RF - Rough field kit fitted.

AIRCRAFT DOCUMENTATION

GENERAL

In accordance with the Air Transport Association (ATA) specifications various manuals, concerning the flight performance, maintenance and repair of the F27 aircraft are issued by FOKKER B.V.
The manuals lay down all the information considered essential for safe operation of the aircraft and to perform the required maintenance and repair schemes.
A brief explanation is presented below of how the information for the maintenance and repair is collated in the various manuals.

The manuals available are:

- Maintenance Manuals (MM)
- Wiring Diagram Manual (WDM)
- Illustrated Parts Catalog (IPC)
- Service Bulletins (SB)
- Service Letters
- Structural Repair Manual
- Illustrated Tool and Equipment Manual
- Component Maintenance Manual
- Non-Destructive Inspection Manual
- Maintenance Data
- Airplane Flight Manual (AFM)

MAINTENANCE MANUAL

This manual contains information about the line-maintenance aspects of the F27. Line-maintenance is defined as: "That maintenance performed on or at the aircraft which includes servicing, replacement, adjustment, testing, inspection, cleaning, painting, and minor repairs not requiring detailed disassembly."

To accomplish this purpose, the F27 maintenance manual contains descriptions, operations and detailed maintenance practices for all systems, assemblies and their related components, trouble shooting charts, general aircraft data and ground handling procedures.

To present this information so that it can be readily located and easily revised, this manual has been prepared in accordance with the Air Transport Association, Specification 100. The following paragraphs explain the method of presentation employed:

- Chapter Listing
  The chapter list, a complete list of the chapters contained in the manual, gives the chapter numbers related to the associated chapter title. The chapter list is one of the first pages of the manual, volume 1.

- Table of Contents (TOC)
  In addition to the chapter listing in the front of the manual, a detailed table of contents is provided on the first page of each chapter.
  Chapter presentation paragraphs appearing on TOC pages are for the purpose of outlining chapter contents and pertinent cross reference.

- Chapter Numbering
  Chapters are divided into smaller, yet related sections through the use of a three-group number. The first part corresponds with the chapter number in all cases. The second part identifies the section and groups of the related sub-systems or assemblies, within the chapter. As shown in the following example, any combination of these two numbers followed by "-00" identifies individual sub-system or assembly presentation. The same combination followed by a digit whose value is greater than "-00" serves to identify related sub-system subjects or components.

```
                                   24  -  30  -  03
                                    |      |      |
CHAPTER/SYSTEM ---------------------       |      |
                                           |      |
SECTION/SUB-SYSTEM ------------------------       |
                                                  |
SUBJECT/COMPONENT ---------------------------------
```

```
 -------      electrical power          -------     electrical power
|                                      |
|   ----      identifies all           |   ----     identifies all
|  |          DC generation            |  |         DC generation
|  |          material                 |  |         material
|  |                                    |  |
|  |   -      identifies all pages     |  |   -     identifies all pages
|  |  |       related to sub-system    |  |  |      related to the
24-30-00      presentation             24-30-03     batteries
```

- Page Numbering

  Data presented in this manual are organized into three categories: description and operation, trouble shooting and maintenance practices.
  To enable breakdown of sections of the manual and as an aid to ready reference, each of the above categories is assigned a block of page numbers as follows:

Description and Operation	1 to 100
Trouble shooting	101 to 200
Maintenance Practices	201 to 300

- Some more complex chapters may appear, in addition to the above categories, in the following breakdown:

- Servicing 301 to 400

- Removal/Installation 401 to 500

- Adjustment/Test 501 to 600

- List of Effective Pages (LEP)

  A list of effective pages, listing all pages which appear in each chapter and the latest date of issue, is filed as the front page(s) of each chapter. The first LEP page bears the date of the latest revision and the date of the previous revision.
  A LEP-summary, bearing the latest date of issue of all lists of effective pages, is filed as one of the first pages of the maintenance manual, volume 1.

- Page-block Code Number

  A page-block code number has been introduced to provide a reference to a particular aircraft. On the name page of the maintenance manual, this is the first page of volume 1, the aircraft serial number is converted into an aircraft effectivity number (first aircraft of an operator: 001, second: 002, etc). On each TOC-page the effectivity number is converted into the page-block codenumber.

WIRING DIAGRAM MANUAL (WDM)

This manual provides maintenance personnel with wiring diagrams, schematics and charts to enable trouble shooting and servicing of the electrical and electronic systems in the aircraft.

The general arrangement of this manual is the same as that of the maintenance, with the following differences:
- Page Numbering
  The wiring diagrams normally have page number 1 -
  The schematics have page number 101 -
- Sheet Number
  A sheet number is used instead of a page-block code number.

For more details about the wiring diagrams refer to chapter 24.00 of the training manual.

ILLUSTRATED PARTS CATALOG (IPC)

This manual gives the partnumbers and locations of components. It also provides name and address of the vendors (vendor code list).
The general arrangement of the catalog is, as far as it concerns chapter number, section number, list of effective pages and table of contents, the same as that for the maintenance manual.

SERVICE BULLETINS (SB)

Due to experience gained in service it may be found that a modification of a system component is required to improve its function.
In this respect a service bulletin is issued with the information necessary for accomplishment. Service bulletins are identified by the applicable ATA chapter number and a serial number.
Compliance with a change or modification may be left to the operator's experience or is required by the authorities.
Alert service bulletins are issued on all matters requiring the urgent attention of the operator and are generally limited to items affecting safety. Matters of extreme urgency are transmitted by cable and later confirmed by an alert bulletin (printed on light blue paper).

SERVICE LETTERS

Service letters are used to transmit advanced information.
The information is later incorporated in the various manuals during the subsequent revision.

STRUCTURAL REPAIR MANUAL

This manual provides the information necessary to maintain the structural integrity of the aircraft. Each chapter presents the structural breakdown of the aircraft in illustrated form. The illustrations depict the specifications and gauges of materials used in the original construction.

Specific detailed repairs and general repair information are presented in written and illustrated examples for the repair of components listed in each chapter.
Information on materials, procedures, such as the material, specification, mechanical properties of metal, corrosion control and corrosion prevention is fully described in chapter 51.

The general arrangement of this manual, as far as it concerns chapter number, section number, list of effective pages and table of contents, is the same as that of the maintenance manual.

ILLUSTRATED TOOL AND EQUIPMENT MANUAL

This manual contains information about the tools and equipment required for the F27. Standard workshop tools and/or equipment are not included.
The general arrangement of this manual is, as far as it concerns chapter number, section number, list of effective pages and table of contents, the same as that of the maintenance manual.

COMPONENT MAINTENANCE MANUAL

This manual provides information, to perform maintenance such as testing cleaning, trouble shooting, repair and check of components manufactured by Fokker B.V.
The general arrangement of this manual is, as far as it concerns chapter number, list of effective pages and table of contants, the same as that of the maintenance manual.

NON-DESTRUCTIVE INSPECTION MANUAL

This manual contains information and specific instructions for non-destructive inspections of the primary and secondary structure of the F27.
The manual comprises eight parts.
Each part gives a description about the principle of the test and its applicability on the various structural parts.
Each part has a list of effective pages.

MAINTENANCE DATA

This document comprises:
- check intervals of the maintenance on aircraft systems and components,
- rotable item list (RIL, maintenance significant components),
- line maintenance checks,
- periodic maintenance checks (operator maintenance program).

The line maintenance check intervals are:
- Service 1 check: Prior to each departure from operating (home) base or maintenance base.
- Service 2 check: Before elapse of 48 calendar hours.
- A-check : Before elapse of 100 flight hours (FH) or two weeks.

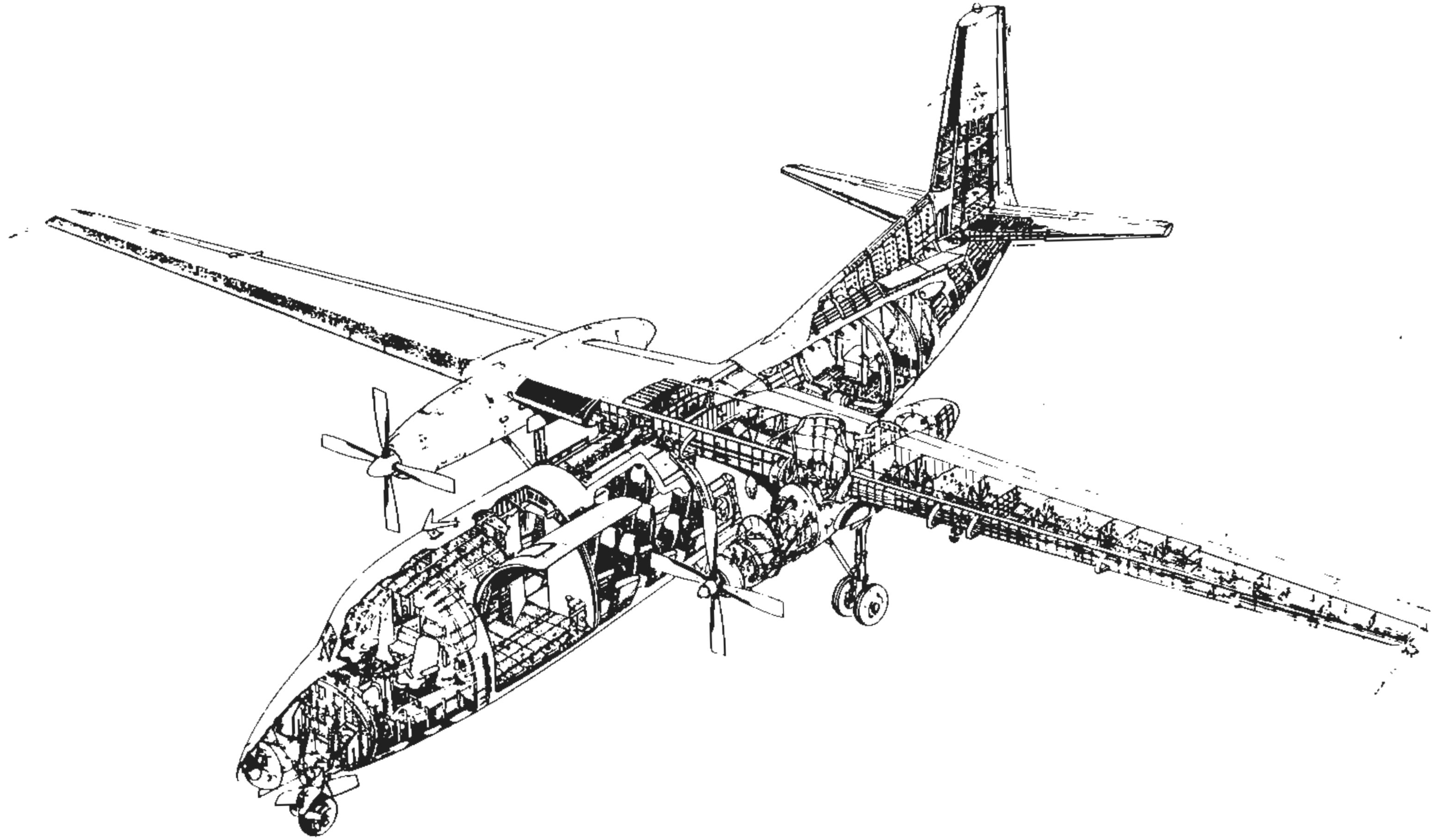
The periodic maintenance-check intervals are:
- B-check : Every 500 FH
- C-check : Every 2000 FH
- D-check : Every 8000 FH

AIRPLANE FLIGHT MANUAL (AFM)

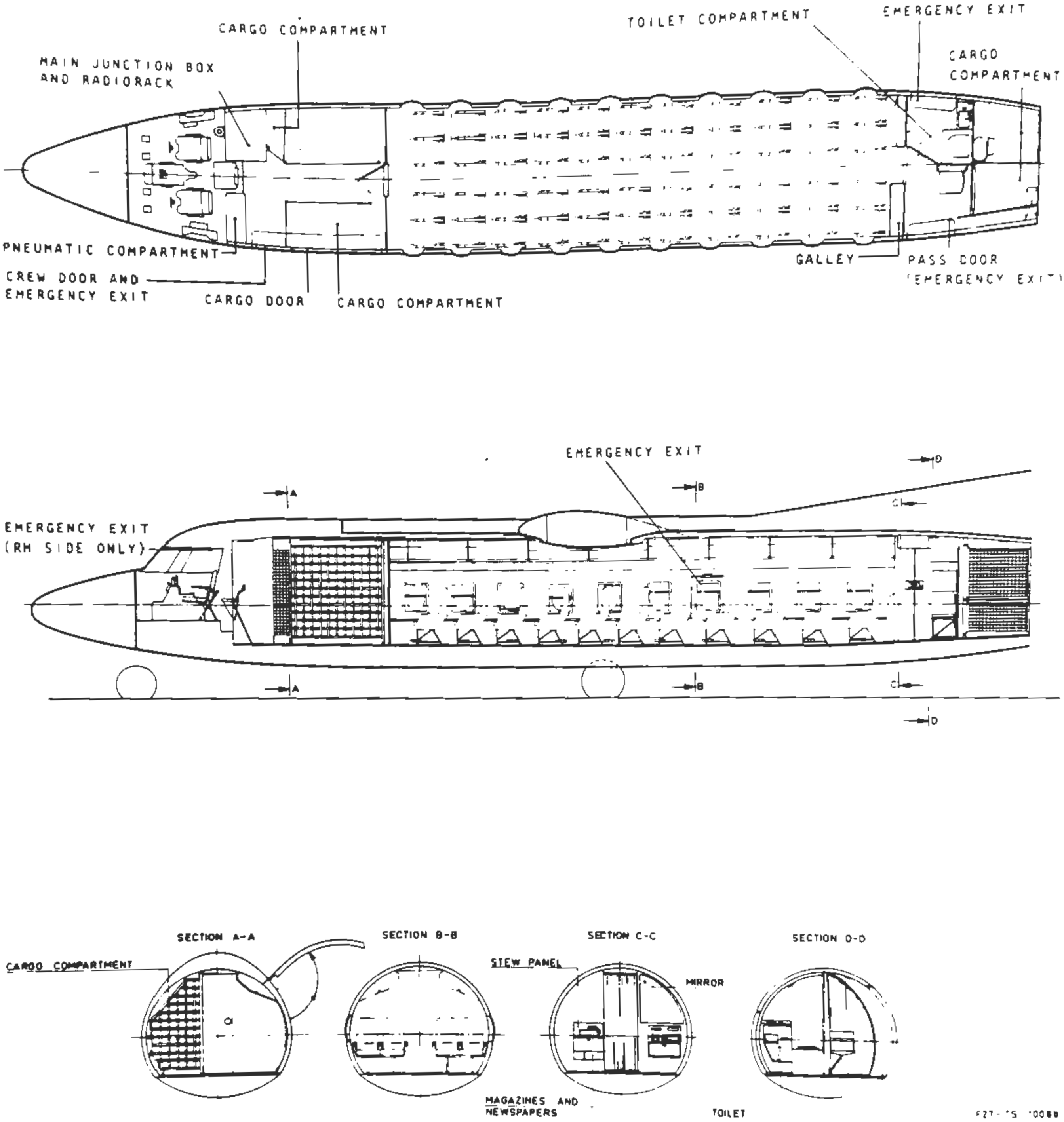
This manual comprises the procedures for handling the F27, on the ground or in flight, for normal, abnormal and emergency operations.

The airplane flight manual is always carried with the aircraft.
Important to engineers is the last chapter of volume 1, allowable deficiencies, in which is written down, whether an aircraft may depart or not with a particular deficiency.

END



F27 FRIENDSHIP



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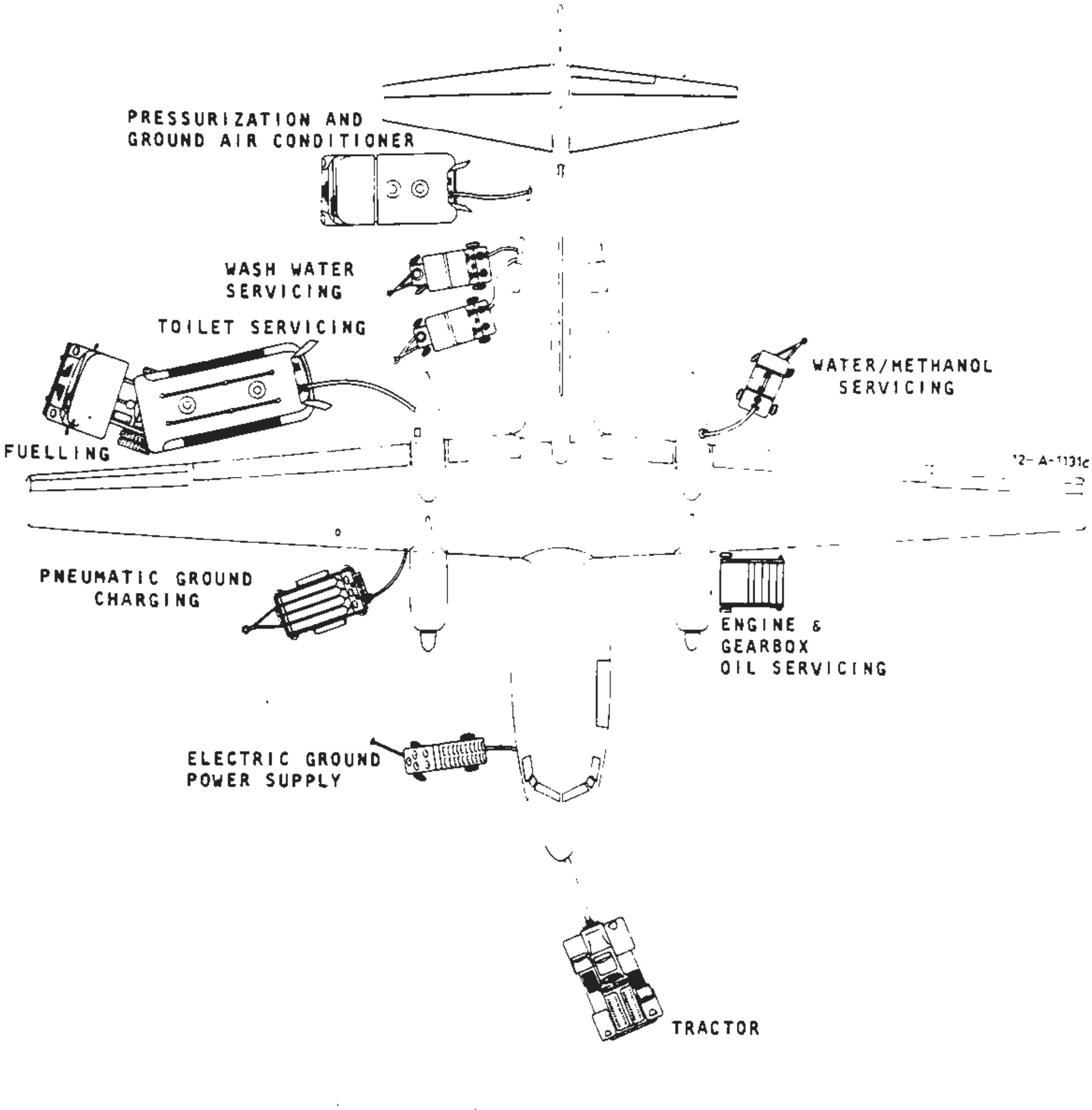
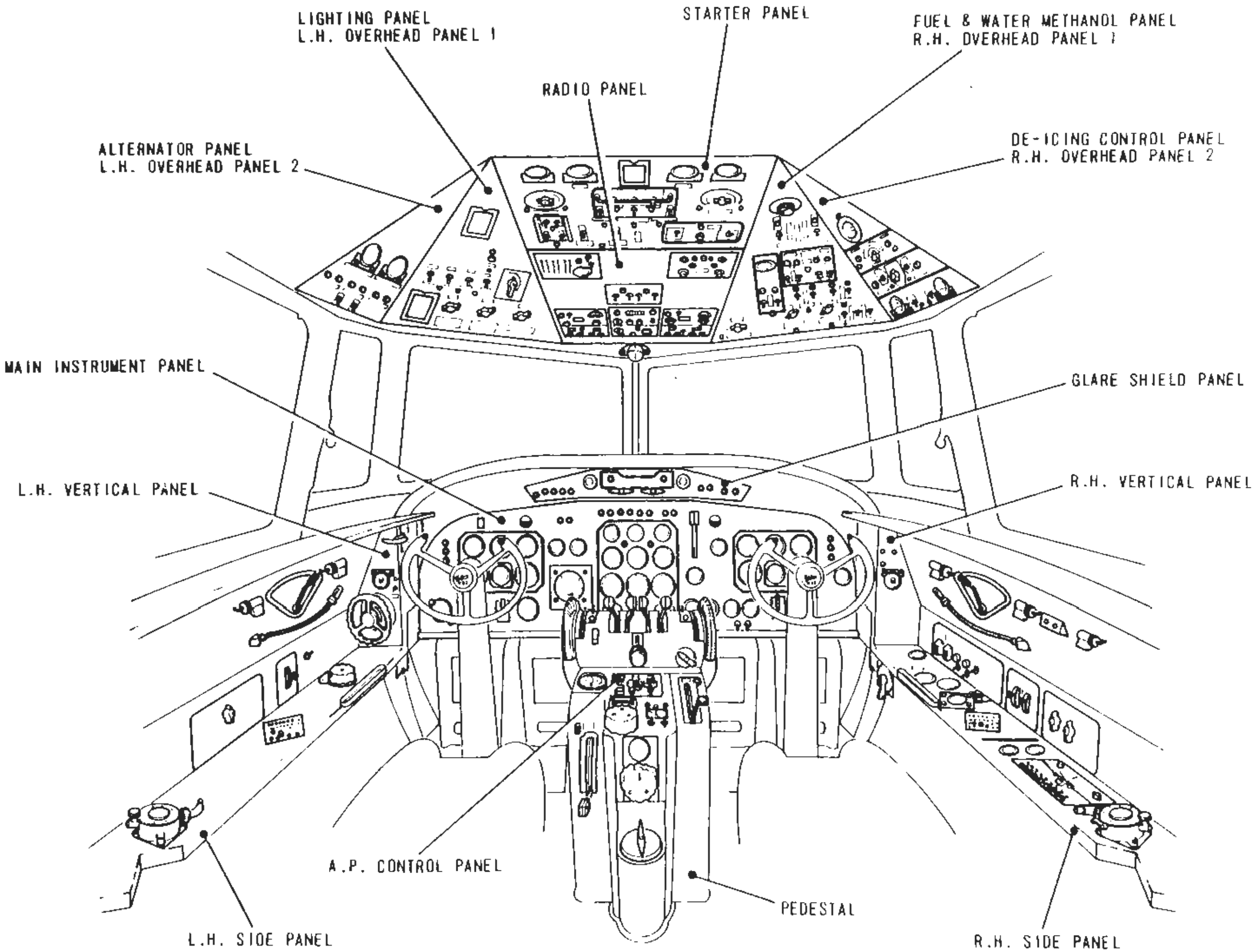
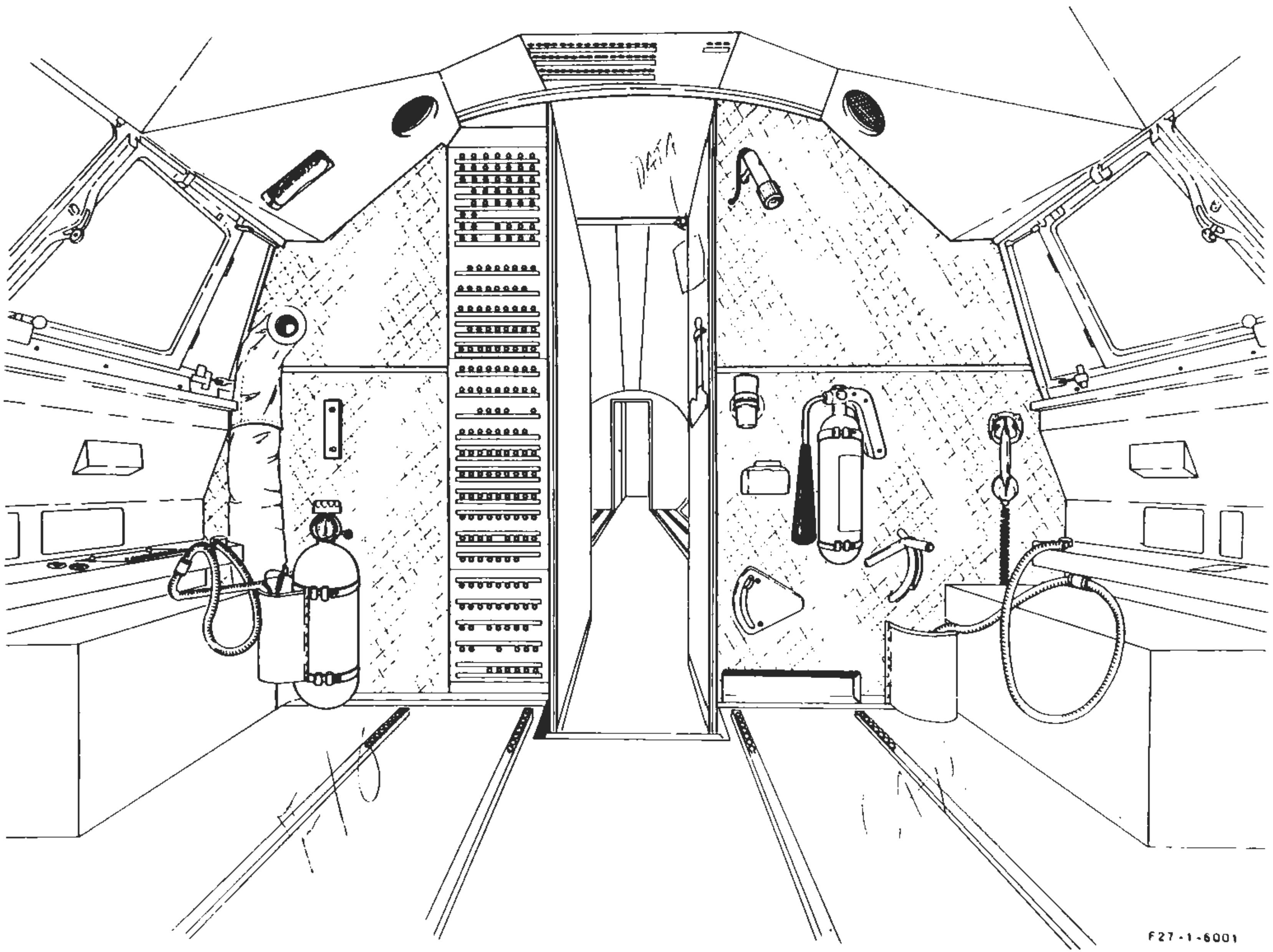


LOCATION OF AIRCRAFT SERVICING EQUIPMENT

LOCATION OF AIRCRAFT SERVICING EQUIPMENT



COCKPIT LAY-OUT, FORWARD VIEW



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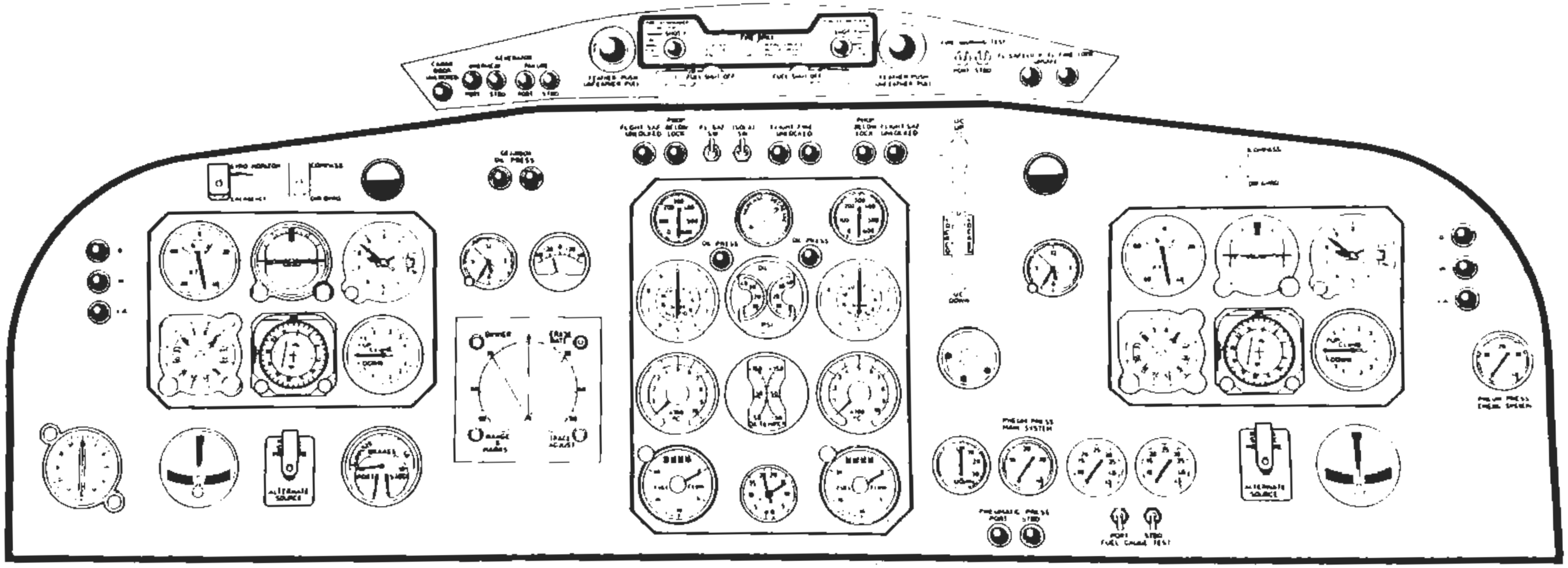
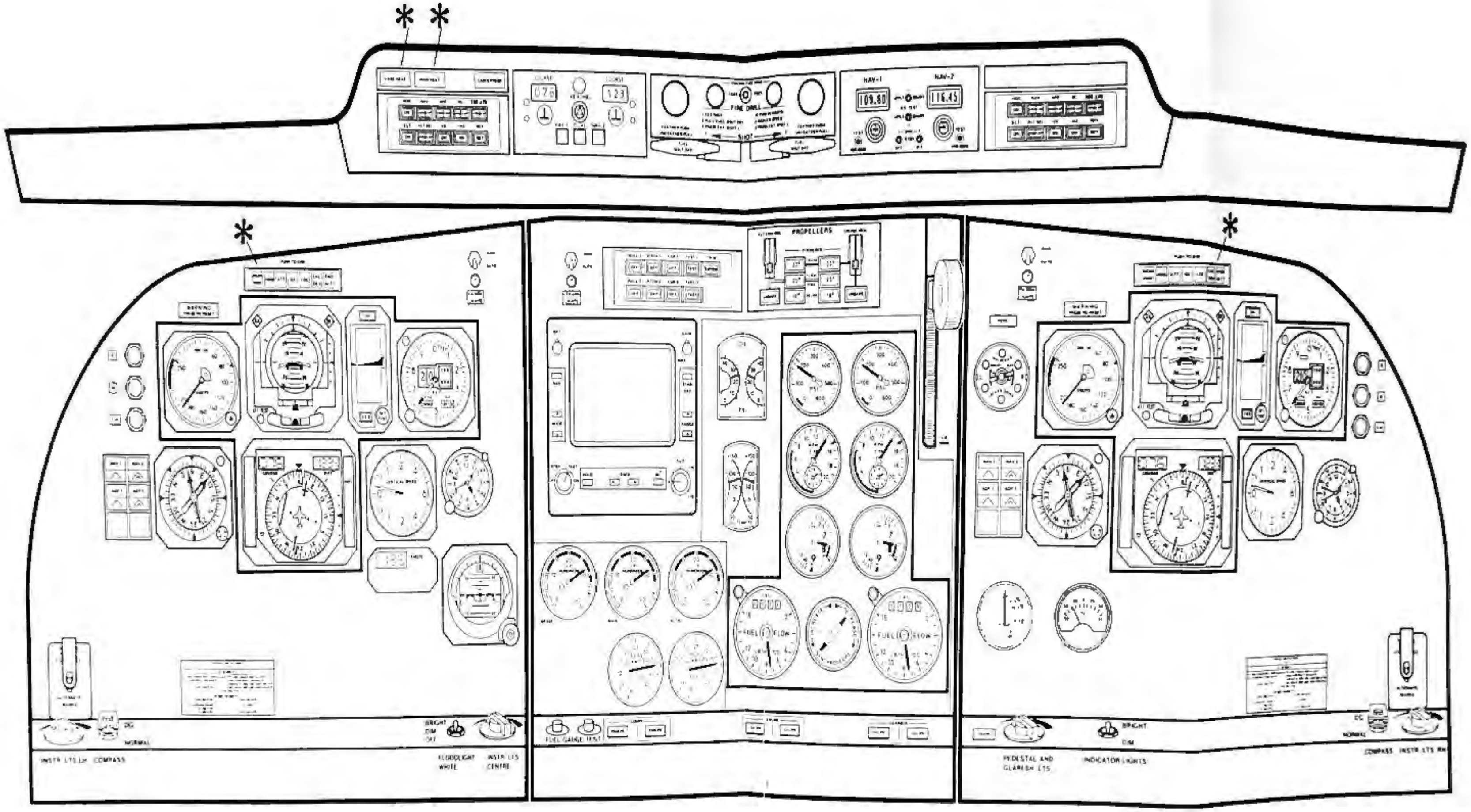
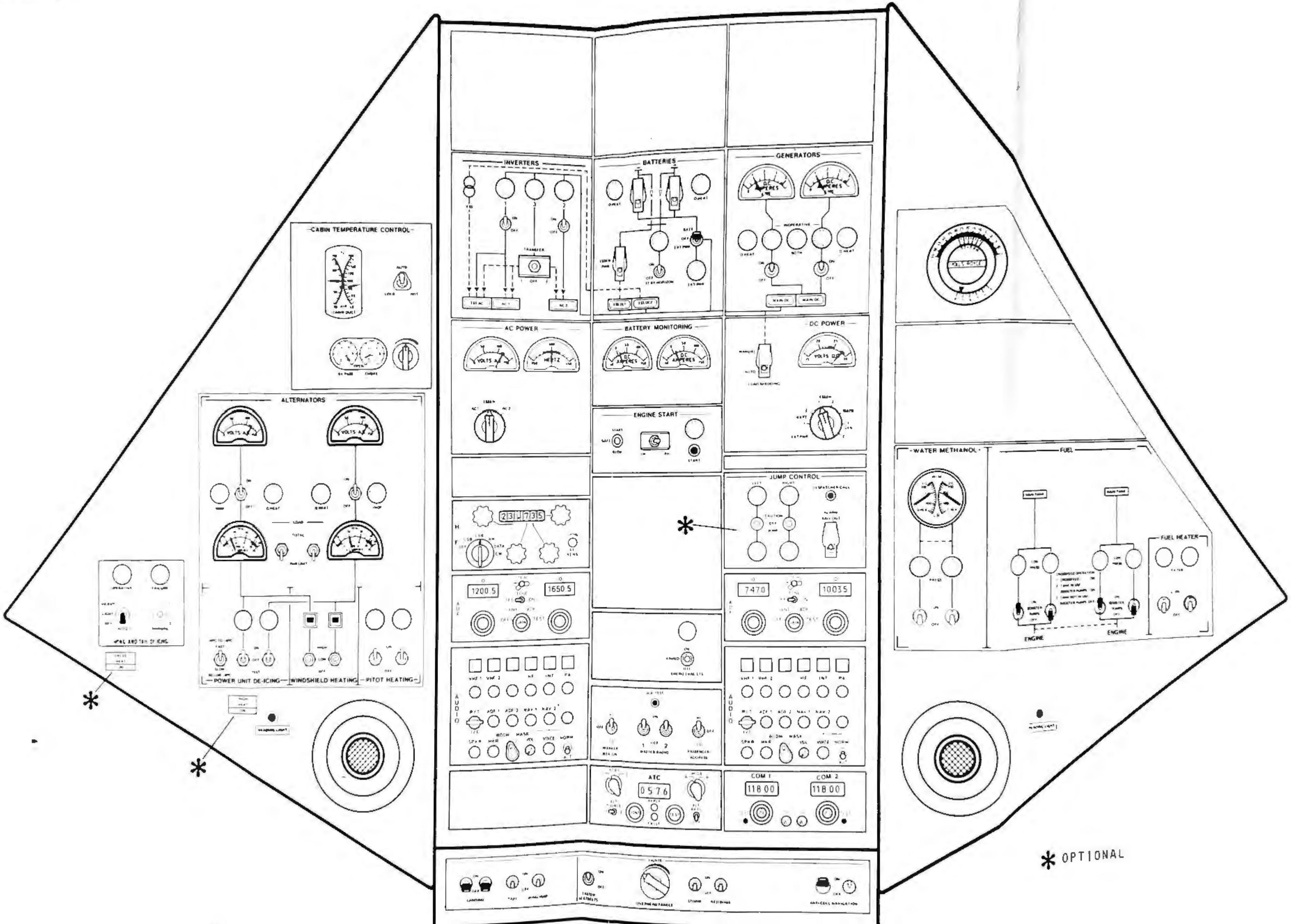


MAIN INSTRUMENT PANELS AND GLARESHIELD PANEL



* OPTIONAL

MAIN INSTRUMENT PANEL AND GLARESHIELD PANEL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INVERTERS
BATTERIES
GENERATORS
AC POWER
BATTERY MONITORING
DC POWER
ALTERNATORS
ENGINE START
JUMP CONTROL
WATER METHANOL
FUEL
FUEL HEATER
POWER UNIT DE-ICING
WINDSHIELD HEATING
PITOT HEATING
1200.5
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7470
10035
ATC
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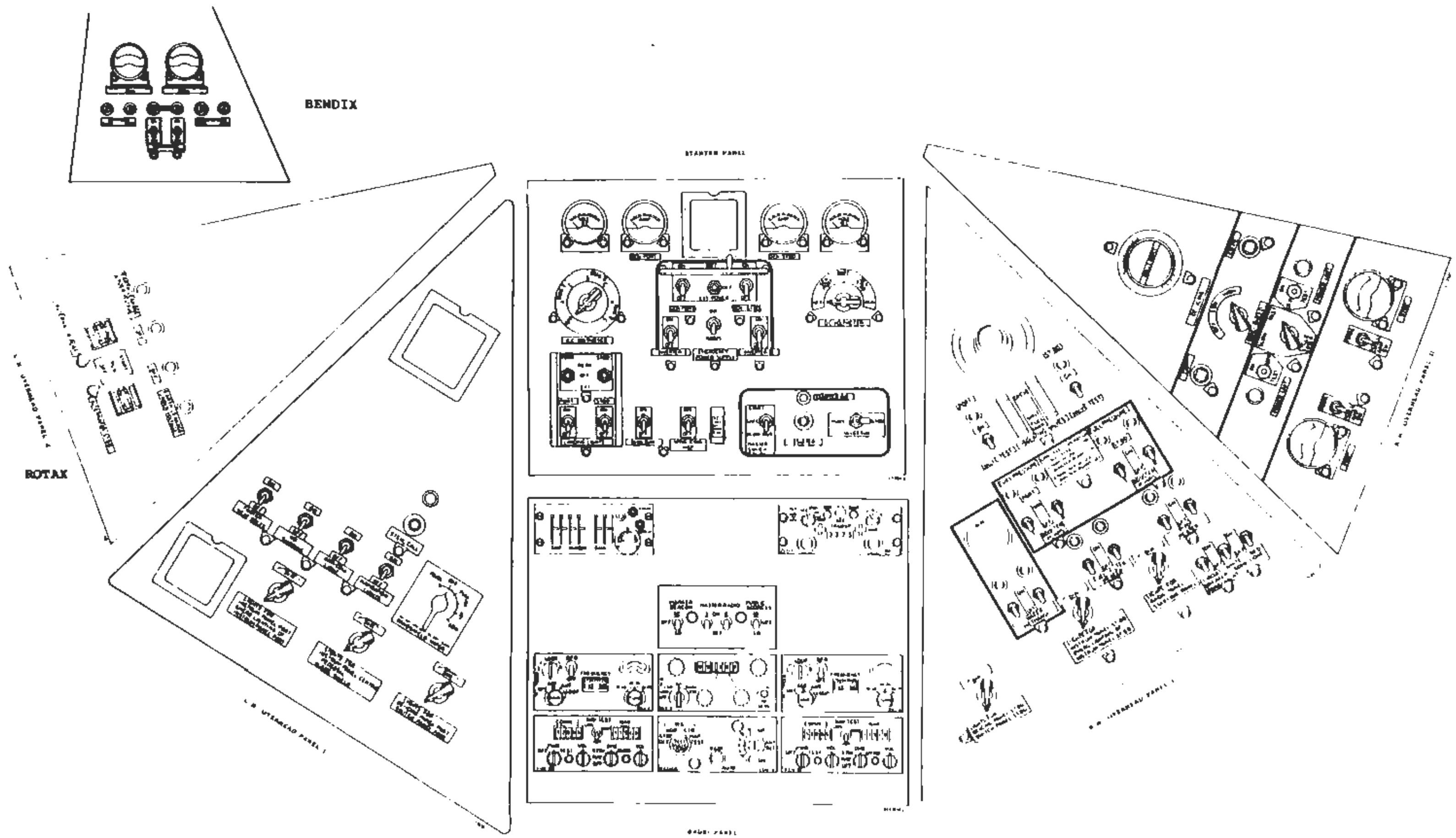
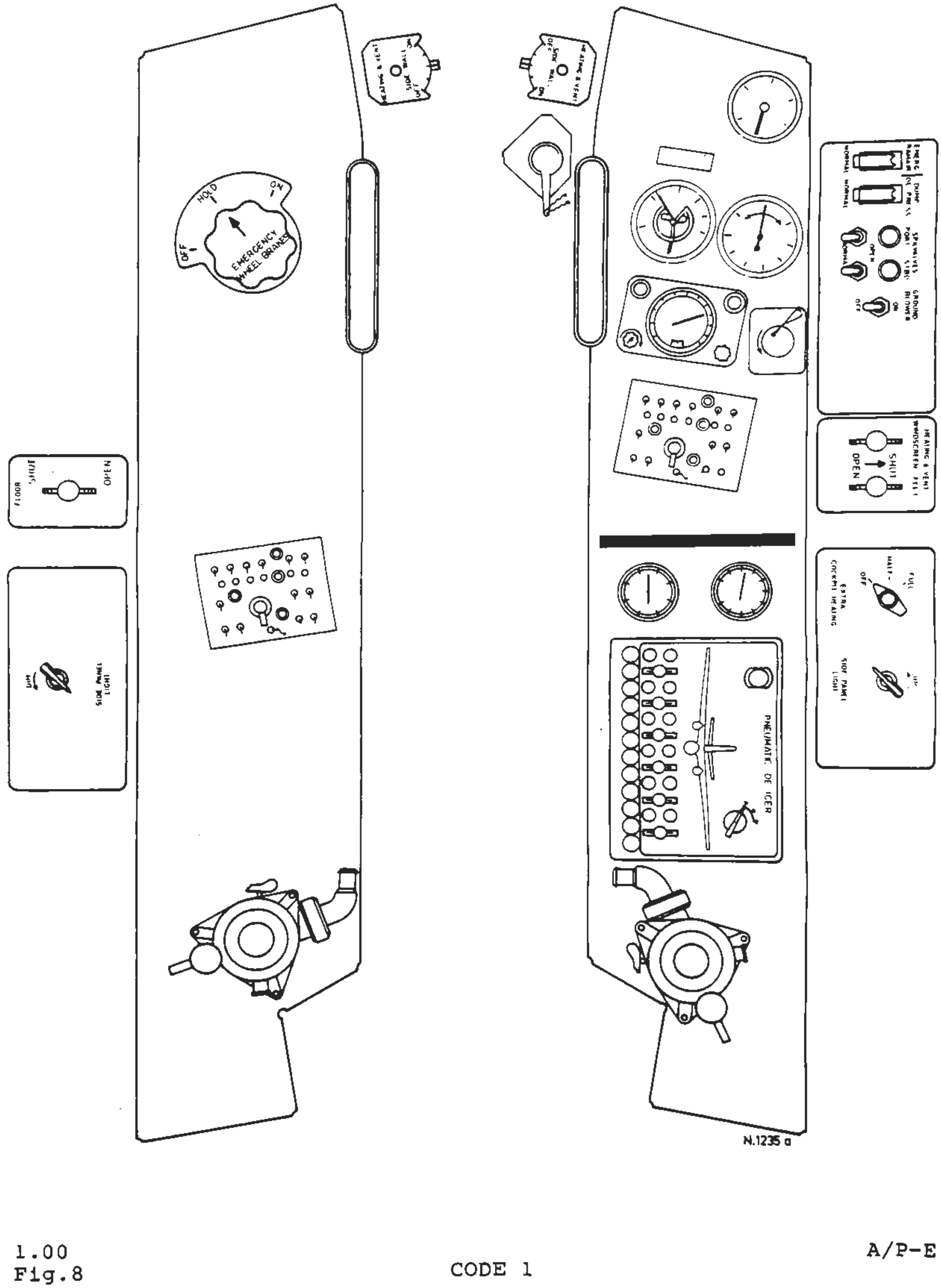
COM 1
COM 2
118 00
118 00
ENGINE
ENGINE

* OPTIONAL



OVERHEAD PANEL


OFF
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FLOOR
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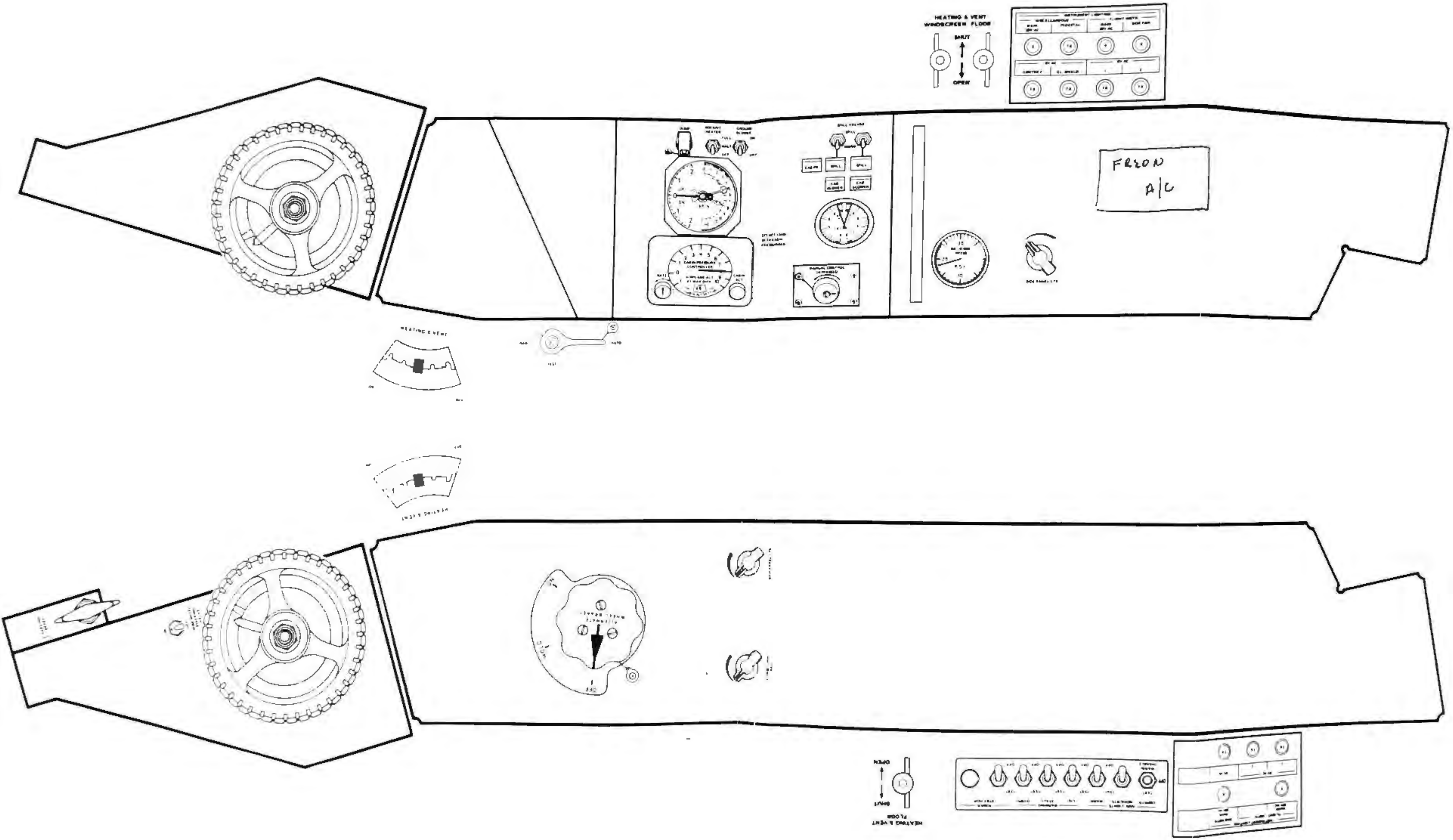
DIM
SIDE PANEL LIGHT
HEATING & VENT
SIDE WALL
PNEUMATIC DE ICER
N.1235 a

SIDE PANELS


HEATING & VENT
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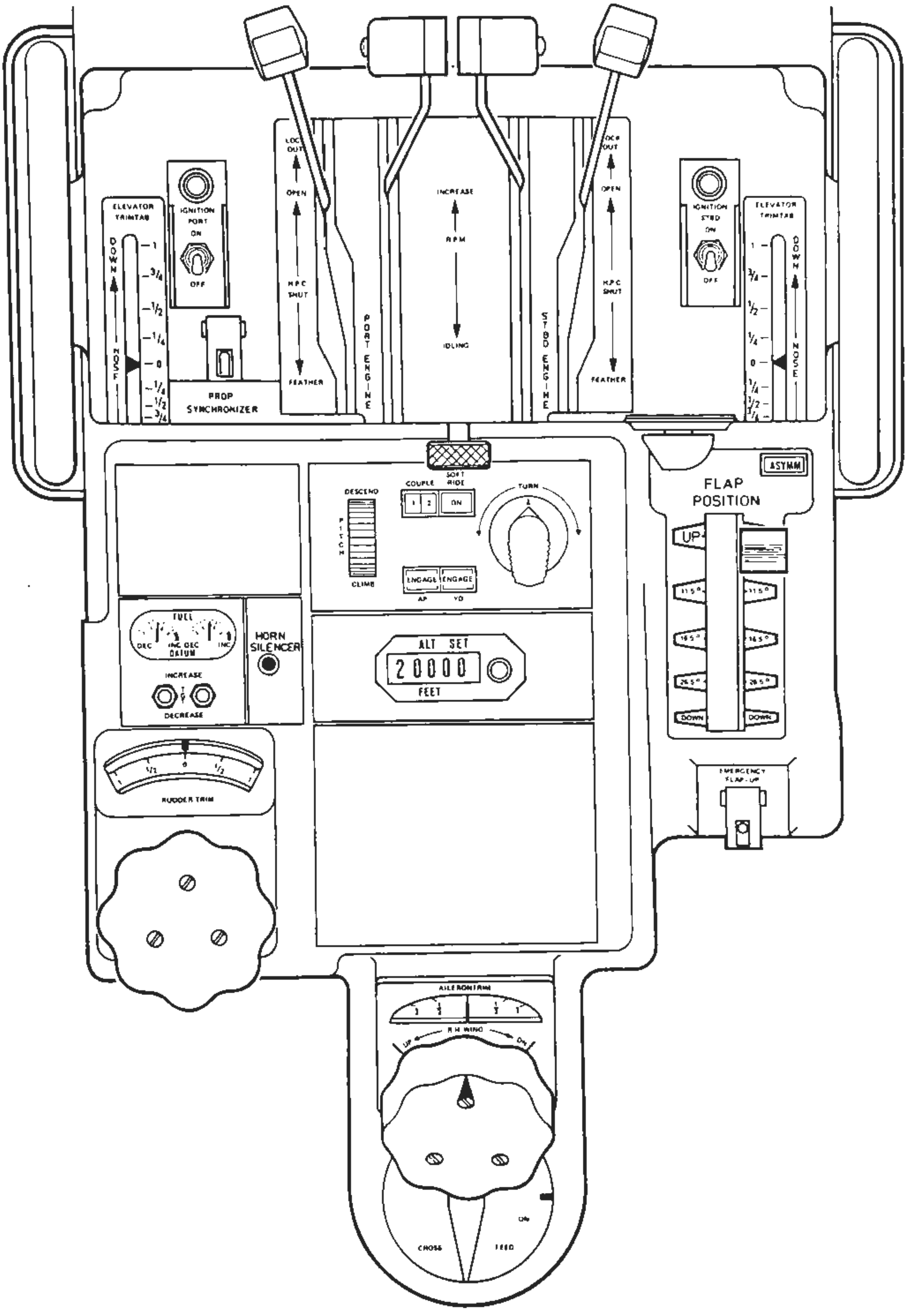
FREON
A/C


ELEVATOR TRIMTAB
DOWN
NOSE
IGNITION PORT
ON
OFF
PROP SYNCHRONIZER
LOCK OUT
OPEN
H.P.C SHUT
FEATHER
PORT ENGINE
INCREASE
R.P.M
IDLING
STBD ENGINE
IGNITION STBD
ASYMM
FLAP POSITION
UP
DOWN
DESCEND
PITCH
CLIMB
COUPLE
SOFT RIDE
ON
TURN
ENGAGE
AP
YD
FUEL
DATUM
INCREASE
DECREASE
HORN SILENCER
ALT SET
20000
FEET
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AILERON TRIM
R.H. WING
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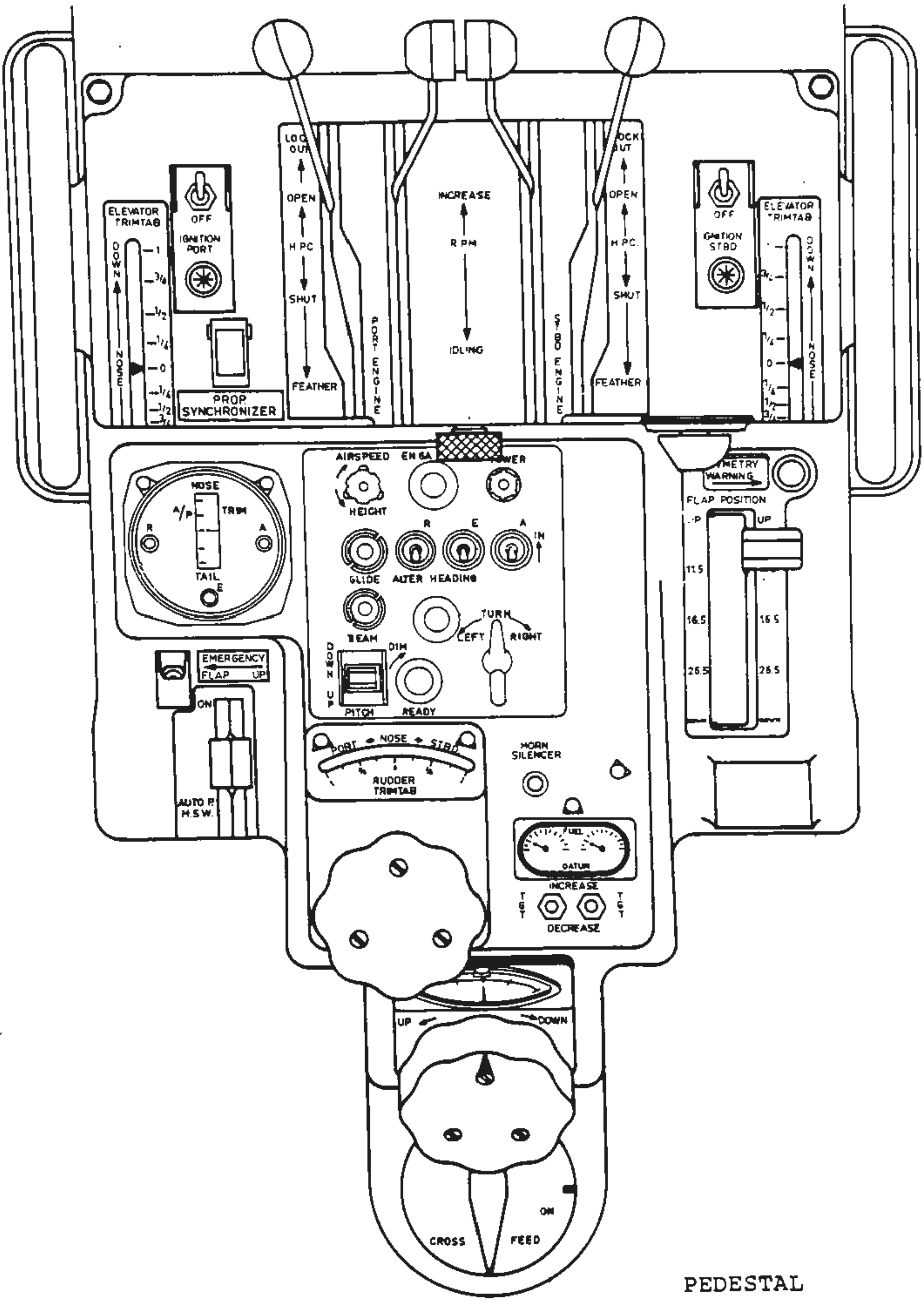
PEDESTAL



PEDESTAL

PEDESTAL

6. DIMENSIONS AND AREAS

00. GENERAL

Some of the principal dimensions of the aircraft are presented in this section and are given in feet and inches with metric equivalents. Areas are given in square feet with equivalents in square metres.

Station positions are given in millimetres and inches and are measured from zero reference points on the longitudinal, lateral and vertical axes.

Station lines along the longitudinal axis of the fuselage are measured from station 0, which is 459 millimetres (18.06 inches) rearward of the aircraft nose. Stations along the lateral axis for wing and horizontal stabilizer are measured from the centre line of the fuselage while for stations on the vertical stabilizer the water line of the fuselage is used as a reference.

Nacelles have their reference point on the leading edge of the engine air intake.

Structurally the aircraft is divided in zones and subzones. Access provisions are identified by an index number.

00.1 External Dimensions Mk-500/500F

GENERAL

Span	95 ft 1.8 in. (29.00 m)
Total length	82 ft 2.5 in. (25.06 m)
Height	29 ft 10.5 in. (9.11 m)
Propeller ground clearance (static)	3 ft 1 in.

WINGS

Chord at root	22 ft 4.4 in. (3.46 m)
Chord at tip	4 ft 7.1 in. (1.40 m)
Chord, mean aerodynamic	8 ft 5.38 in. (2.58 m)
Airfoil section (root)	NACA 64/4-421 (Mod.)
Airfoil section (tip)	NACA 64/2-415 (Mod.)
Taper ratio	2.5 : 1
Dihedral (outer wing)	2.5 degrees
Incidence (at root)	3 degrees 27 min.
Wash-out	2 degrees
Aspect ratio	12
Total area	754 sq. ft (70 m2)

FLAPS

Total span	65 ft 6 in. (20.00 m)
Total area	590 sq. ft (54.8 m2)

FUSELAGE

Width	8 ft 10 in. (2.70 m)
Height	9 ft 1.7 in. (2.79 m)

EMPENNAGE

Vertical stabilizer height	15 ft 4.8 in. (46.95 m)
Horizontal stabilizer span	32 ft (9.75 m)
Dihedral	6 degrees

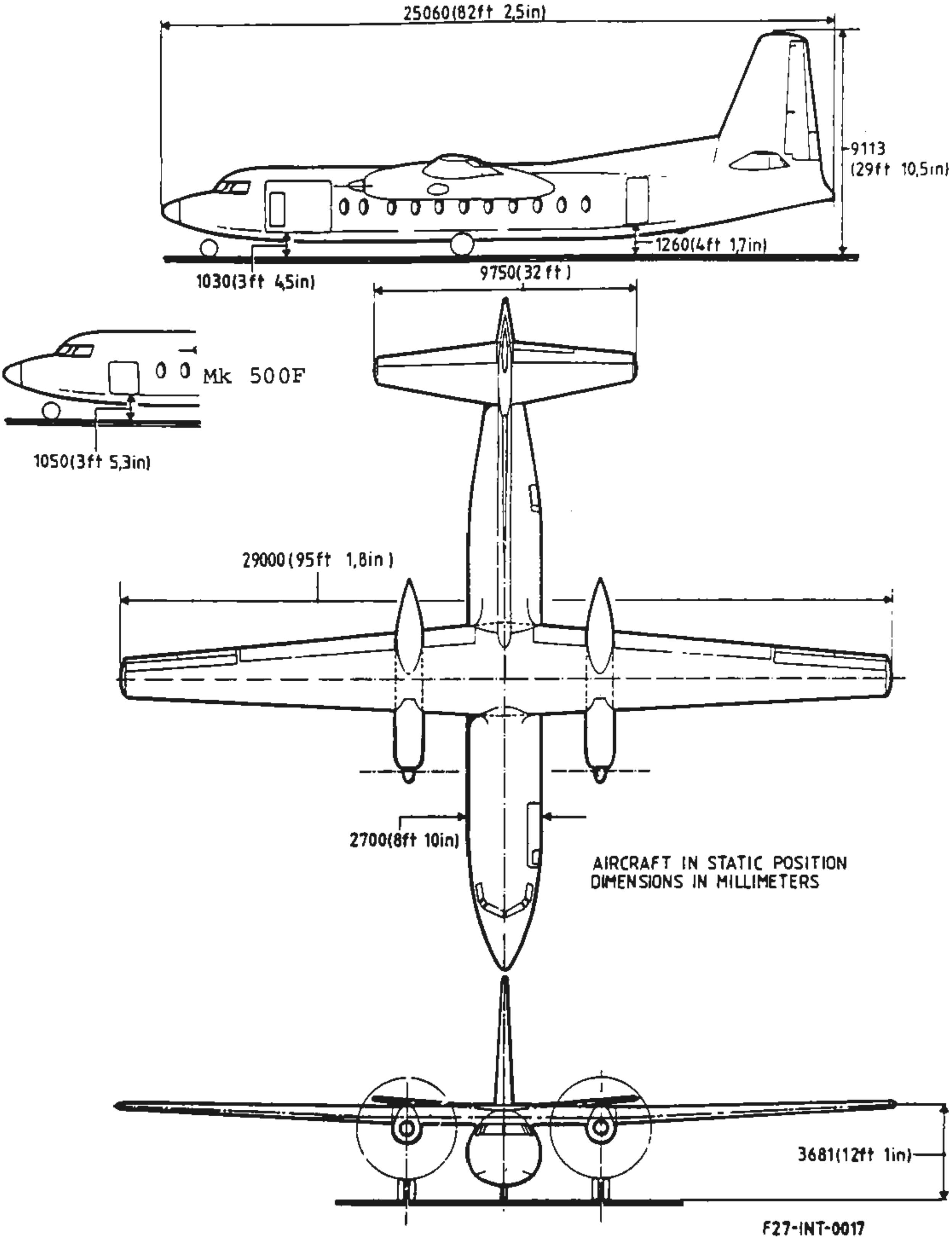
00.2 Dimensions of Doors and Windows Mk-500

Large cargo door	70 x 91.5 inches (177 x 232 centimetres)
Height of door level above ground	3 ft 4.5 in. (103 centimetres)
Crew door	48.9 x 23.4 inches (124 x 59 centimetres)
Entrance door	65 x 29 inches (165 x 73 centimetres)
Height of door level above ground	4 ft 1.7 in. (126 centimetres)
Emergency exit	44 x 28 inches (111 x 73 centimetres)
Emergency escape hatch	26.4 x 19.2 inches (67 x 48 centimetres)

00.3 Dimensions of Doors and Windows Mk-500F

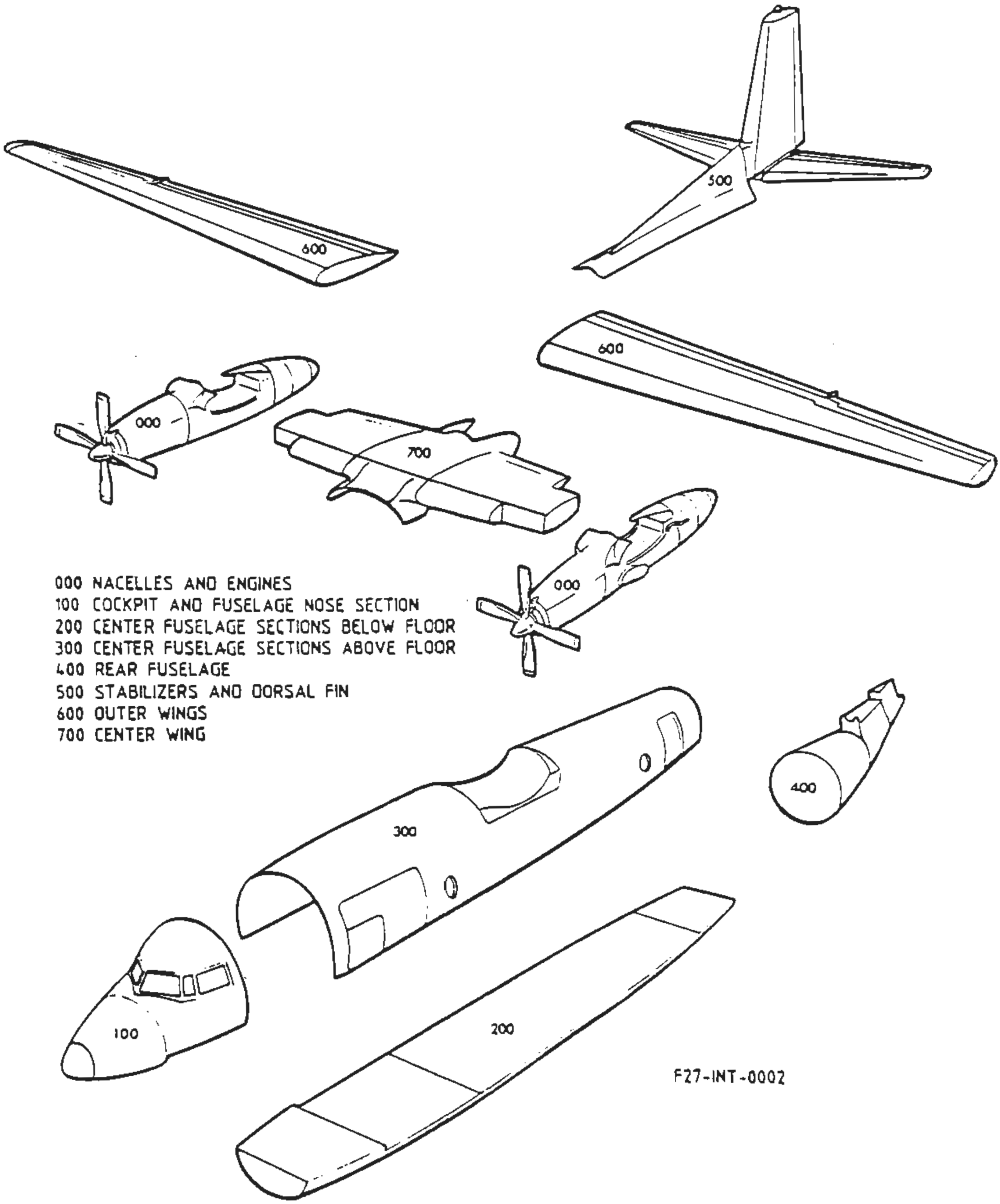
Crew door	47 x 40.8 inches 119.4 x 103.6 centimetres)
Height of door level above ground	3 ft 5.3 in. (105 centimetres)
Entrance door, emergency exit and escape hatch	See Mk-500

END

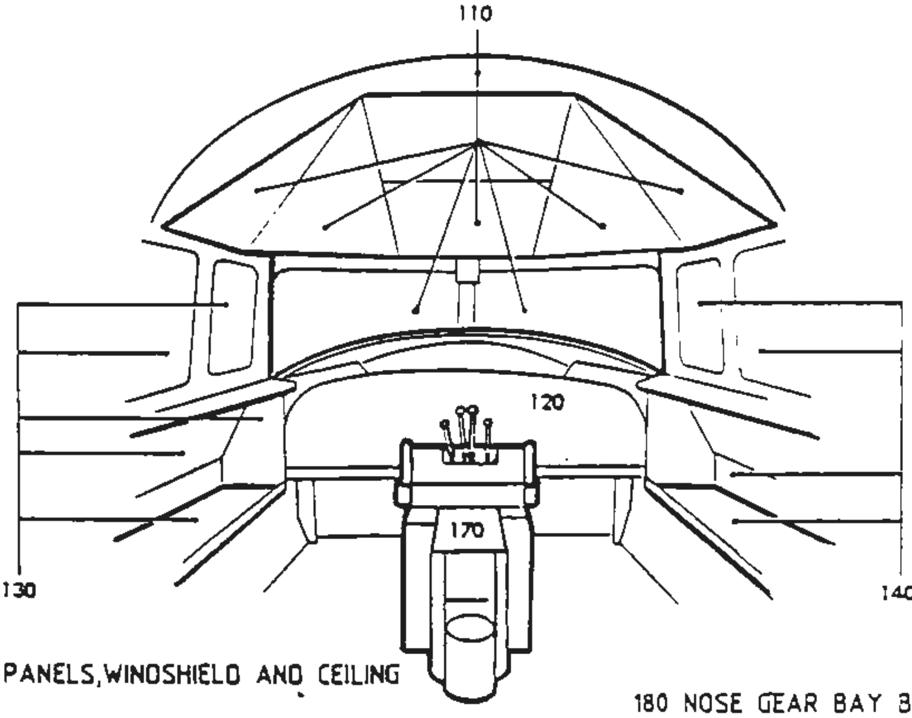


GENERAL ARRANGEMENT Mk 500/ 500F

GENERAL ARRANGEMENT Mk 500/ 500F


600
500
600
000
700
000
000 NACELLES AND ENGINES
100 COCKPIT AND FUSELAGE NOSE SECTION
200 CENTER FUSELAGE SECTIONS BELOW FLOOR
300 CENTER FUSELAGE SECTIONS ABOVE FLOOR
400 REAR FUSELAGE
500 STABILIZERS AND DORSAL FIN
600 OUTER WINGS
700 CENTER WING
400
300
100
200
F27-INT-0002

MAJOR ZONES



110 OVERHEAD PANELS,WINDSHIELD AND CEILING

120 COCKPIT WALL AND MAIN INSTRUMENT PANEL

130 LH COCKPIT WALL,WITH LH SIDE PANEL, INCLUSIVE DIRECT VISION AND SLIDING WINDOWS

140 RH COCKPIT WALL,WITH RH SIDE PANEL,INCLUSIVE DIRECT VISION AND SLIDING WINDOWS

150 PILOTS SEATS,CONTROL COLUMN, COCKPIT ENTRANCE AND -STEP

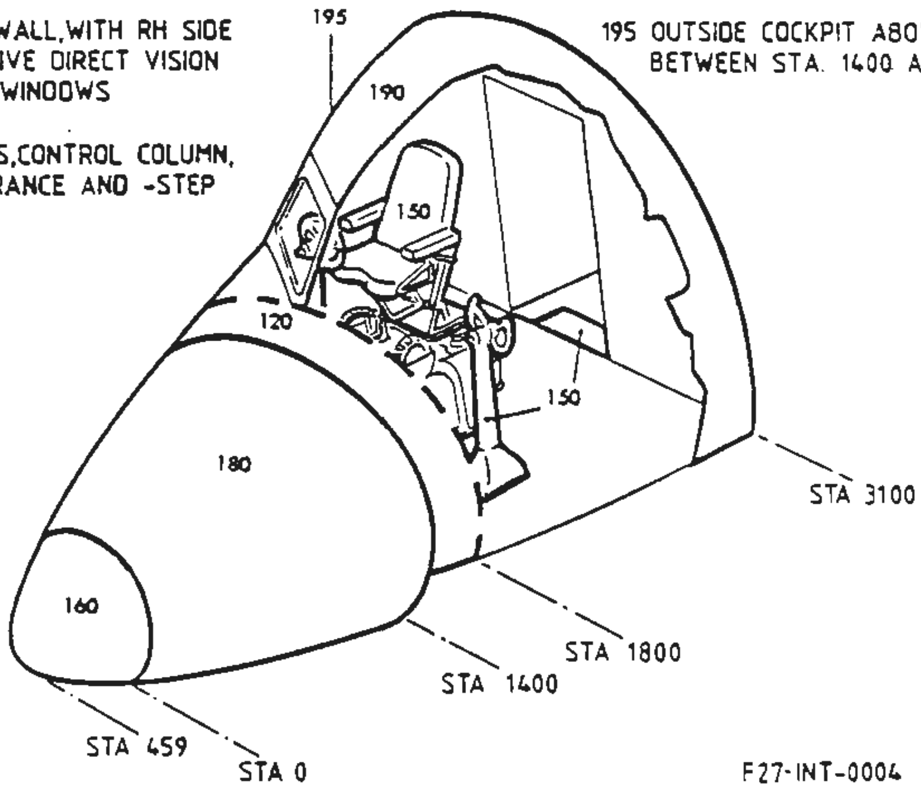
160 RADOME

170 PEDESTAL

180 NOSE GEAR BAY BETWEEN STA 60 AND STA. 1400

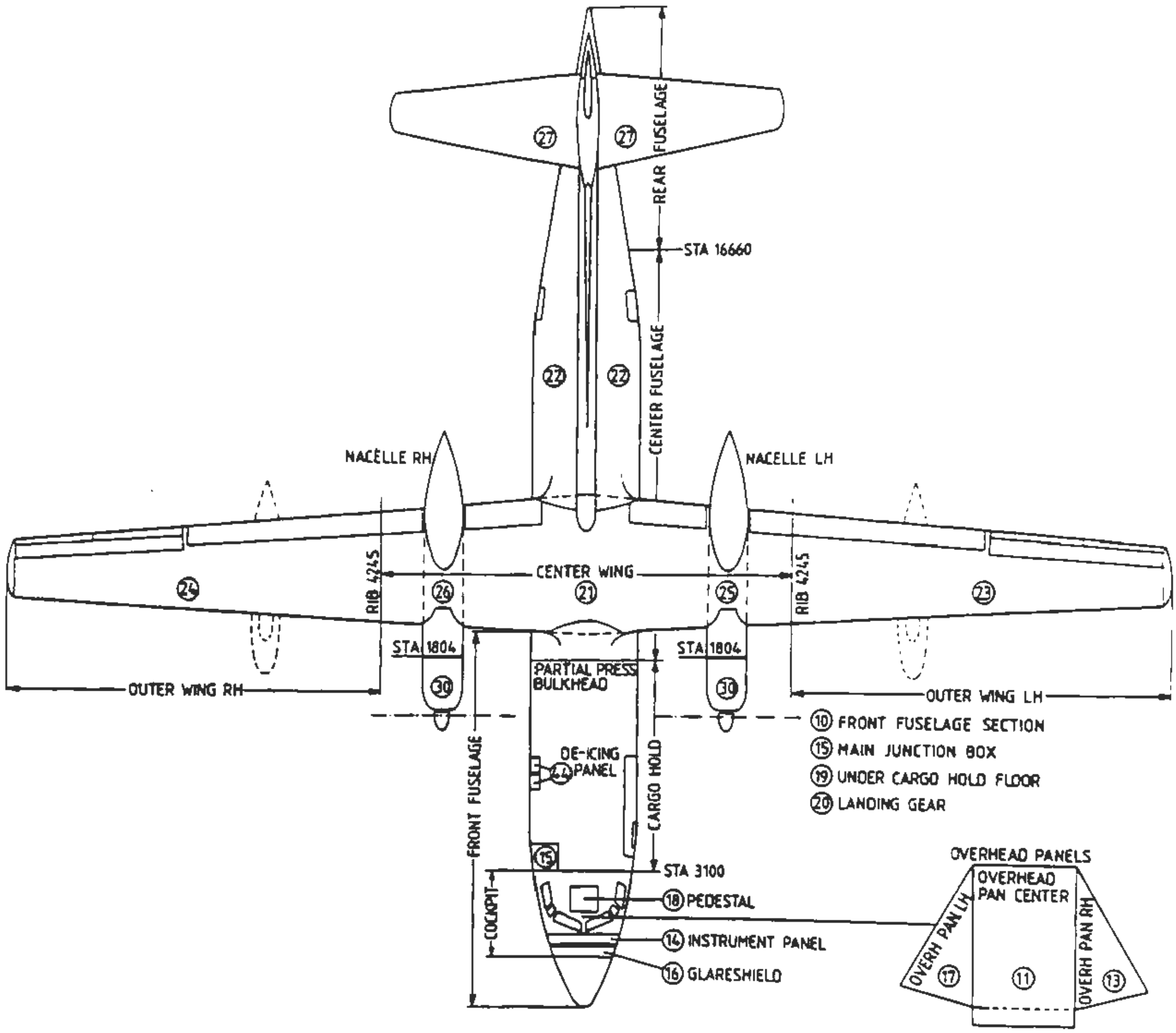
190 INSIDE COCKPIT ABOVE BEND LINE, BETWEEN STA. 1400 AND STA. 3100

195 OUTSIDE COCKPIT ABOVE BEND LINE, BETWEEN STA. 1400 AND STA. 3100



F27-INT-0004

MAJOR ZONES 100, BREAKDOWN



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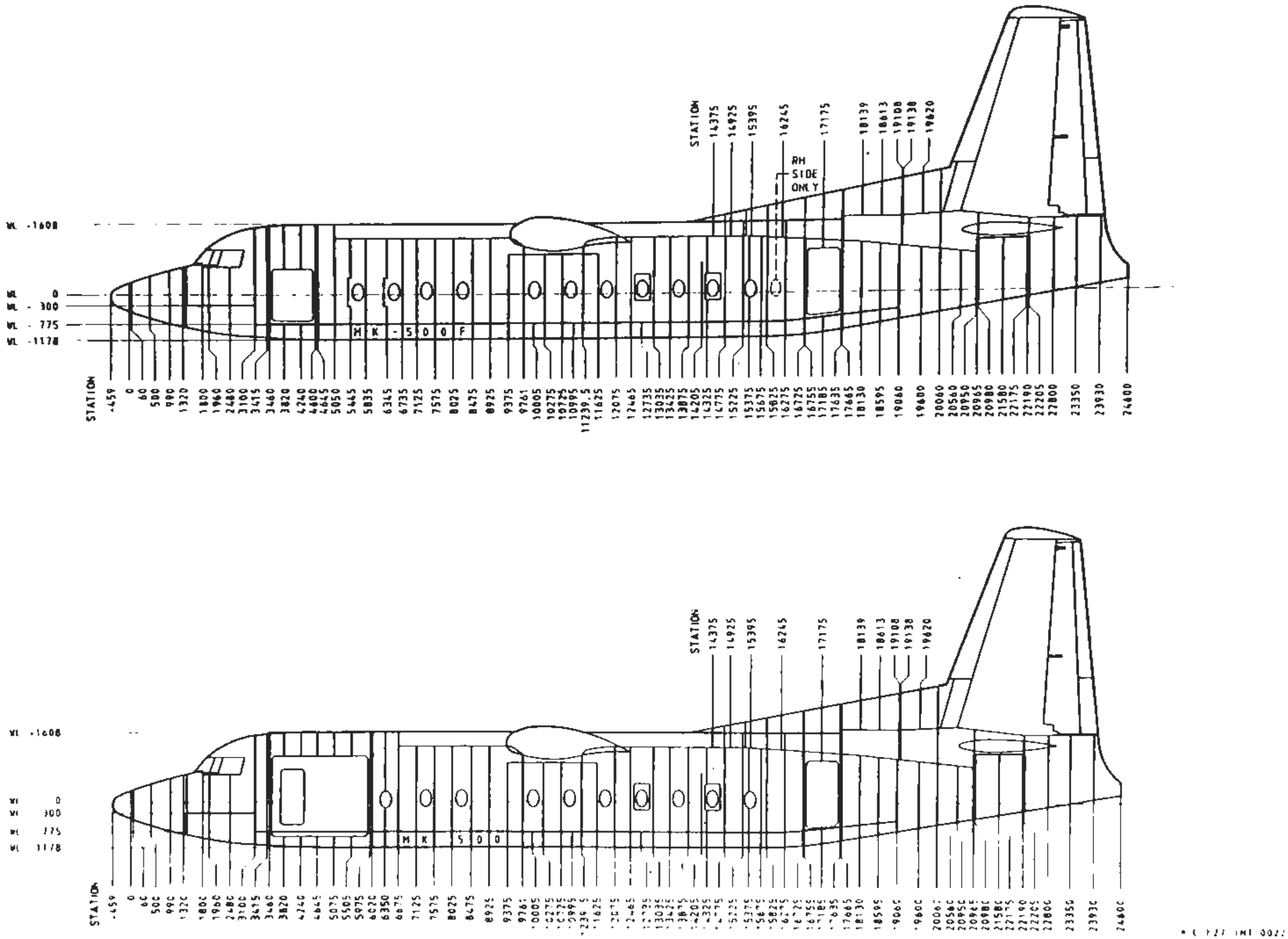
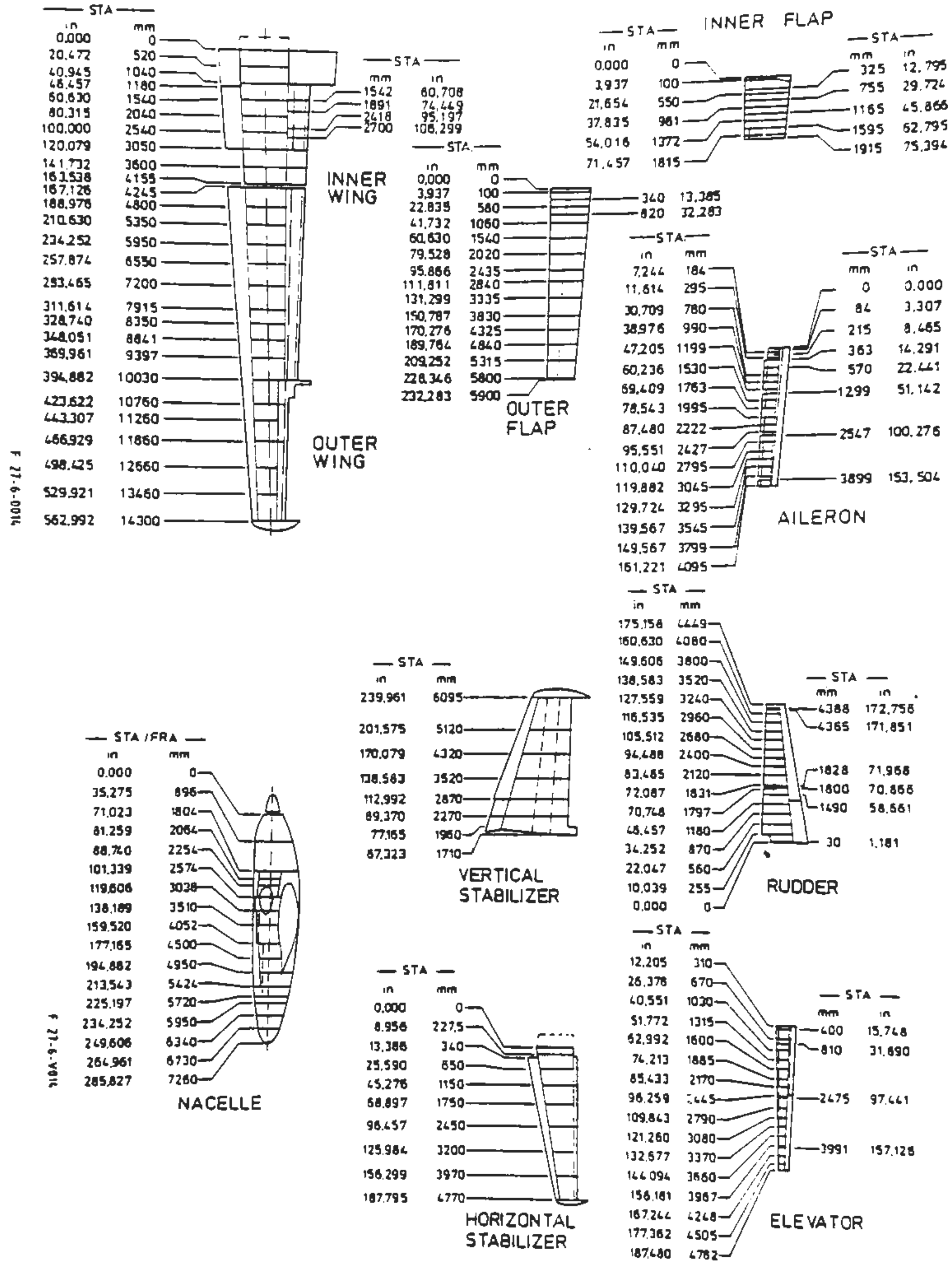
LOCATION IDENTIFICATION



Mk-500/500F STATION DIAGRAM, ZONES 100, 200, 300, AND 400



ALL MARK STATION DIAGRAM, ZONES 000, 500, 600 AND 700

[illegible] AND SHORING

7. LIFTING AND SHORING

00. GENERAL

This chapter deals with the procedures for jacking the complete aircraft and jacking at the landing gear including methods of supporting the aircraft when engines are removed.

Jacking is permitted up to the maximum take-off weight of the aircraft.

For hoisting of aircraft components reference should be made to the relevant chapter in the Maintenance Manual.

Shoring of the fuselage and/or the wings should be considered whenever structural repairs are to be made to these components.

10.0 JACKING

10.1 Aircraft Jacking

The entire airplane is raised at three jacking points on the primary structure airplane.

The front fuselage jack point is located 20 millimeters behind the junction of station 3100 and the right-hand floor beam. The two wing jack points are at wing stations 2540 on the rear spar.

When not in use, the jack points are faired over with threaded plugs to retain aerodynamic smoothness. A special screwdriver has to be used for removal or installation of the plugs.

Jacking operations should be synchronized to keep the airplane in a level attitude so as to prevent overloading by side loads. For jacking of the aircraft at the nose and wings, jacks capable to lift 5,000 lb and 20,000 lb respectively are necessary.

10.2 Wheel Jacking

Main gear wheel or brake servicing is done by raising the main gear shock strut by means of a jacking adaptor under the wheel axle. If both tyres on one gear are flat a special bridge assembly should be used together with two jacks. This is necessary because the ground clearance with two flat tyres is not sufficient to permit the use of a normal jack.

To jack the nose wheel a special set of tools is used. The set has:
- a jack support which is connected to the suspension hinge point,
- a shock-absorber distance piece which prevents the shock absorber to compress
- and two steering motor locks which keep the steering motor in the centre position.

WARNING: DO <u>NOT</u> DISCONNECT THE NOSE GEAR STEERING DURING NOSE GEAR JACKING.

When jacking under the nose gear, or at the main gear adaptors, the gears should only be lifted high enough for the tyres to clear the ground.

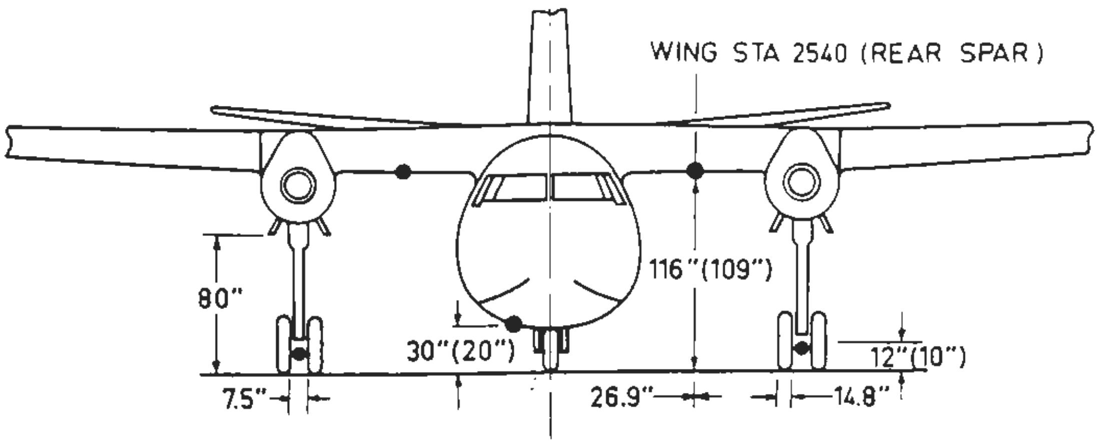
Aircraft Jacking Precautions

1. Ensure that the parking brake is at OFF when jacking the aircraft.
2. Loose cargo, tools and equipment should be removed before jacking.

WARNING: THE WATER/METHANOL TANKS MUST BE DRAINED BEFORE JACKING FOR ENGINE REMOVAL UNLESS A TAIL SUPPORT OR FRONT CARGO COMPARTMENT BALLAST IS USED, WEIGHT OF THE WATER/METHANOL MAY SHIFT THE CENTRE OF GRAVITY TOO FAR AFT.

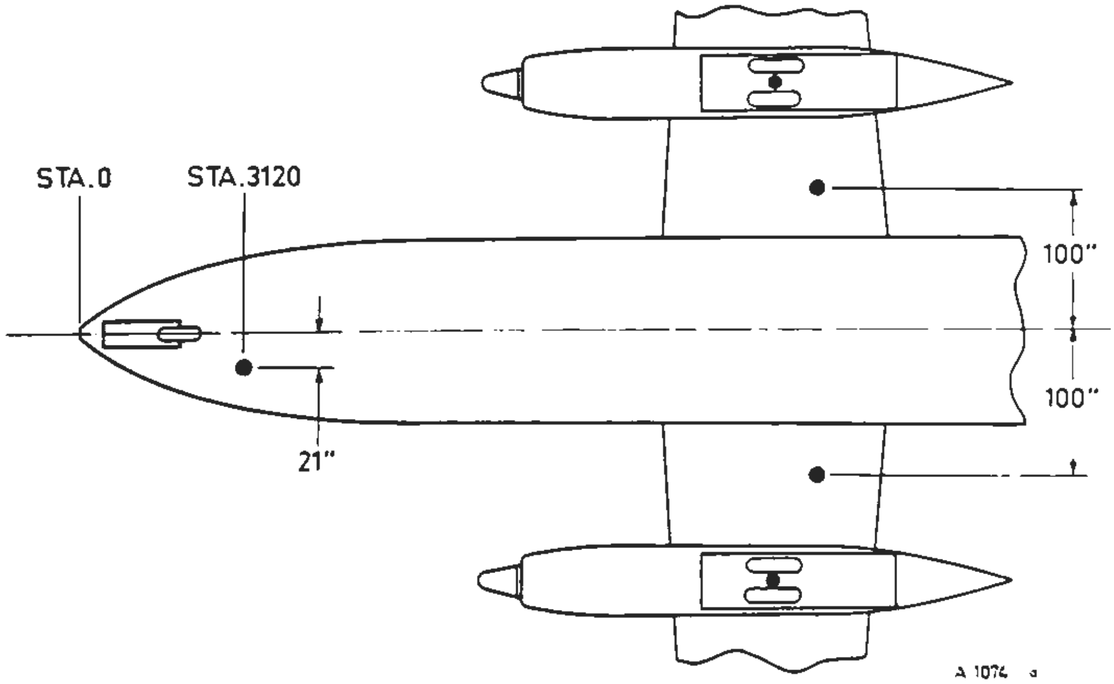
3. Head the aircraft into the wind if jacking is carried out outdoors. Do not jack if the wind velocity exceeds 10 knots (18.5 km/h) unless the aircraft is secured at all mooring points. Release mooring ropes simultaneously when jacks are raised. Do not jack at all if gusts exceed 20 knots (37 km/h).
4. Ensure that the aircraft is reasonably level prior to jacking.
5. Wing jacks must always be used in pairs.
6. Lock the jacks immediately after jacking to prevent inadvertent lowering.
7. Personnel may work in the tail when one or both engines are removed, provided a tail support is used or 500 pounds (225 kg) ballast per man is placed in the front cargo compartment.
8. Install the landing gear ground locks before lowering the aircraft.

END

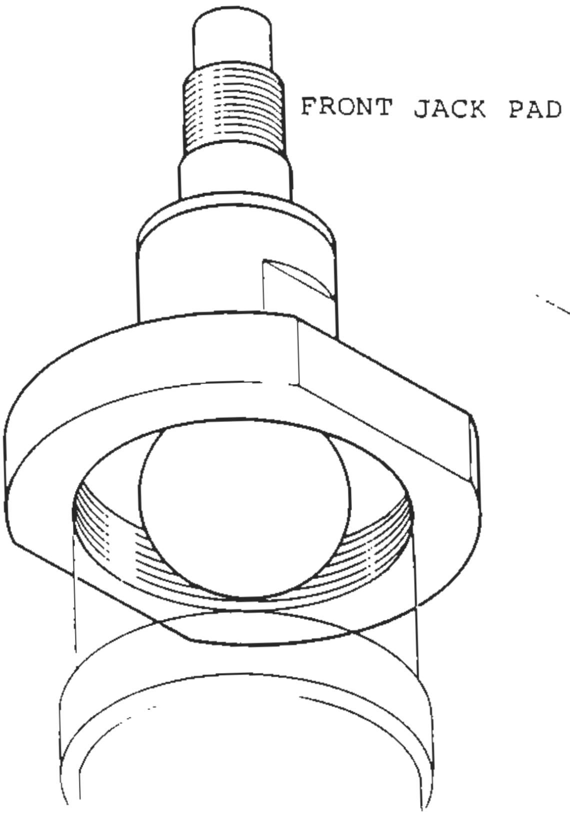


STATIC CONDITION
( )OLEOS COMPRESSED AND
TIRES DEFLATED

● JACK POINT



JACKING POINTS



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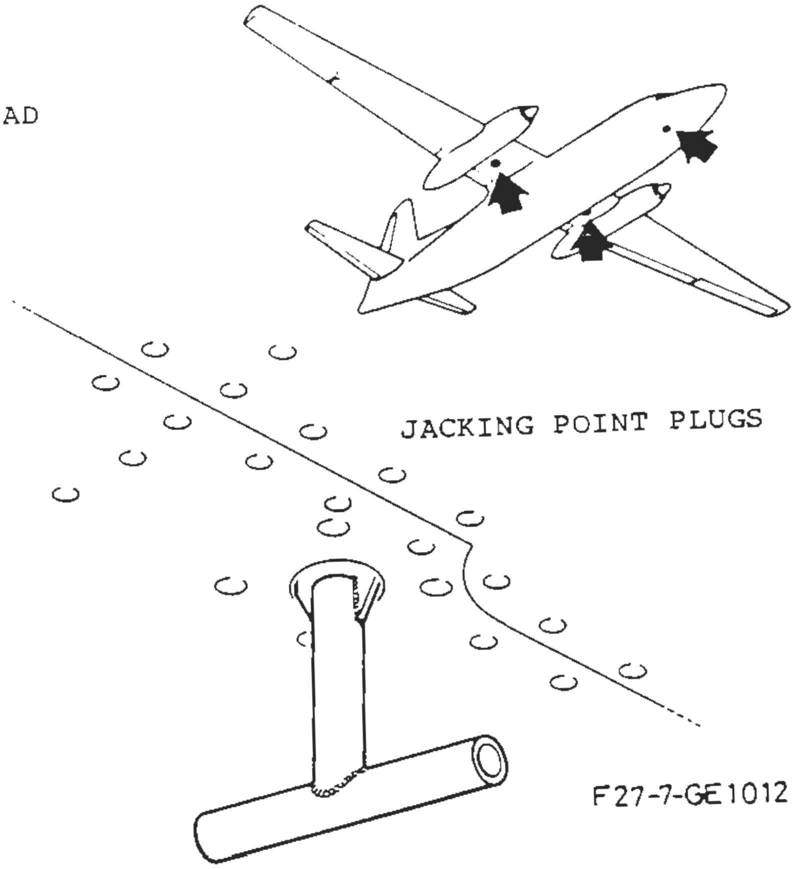

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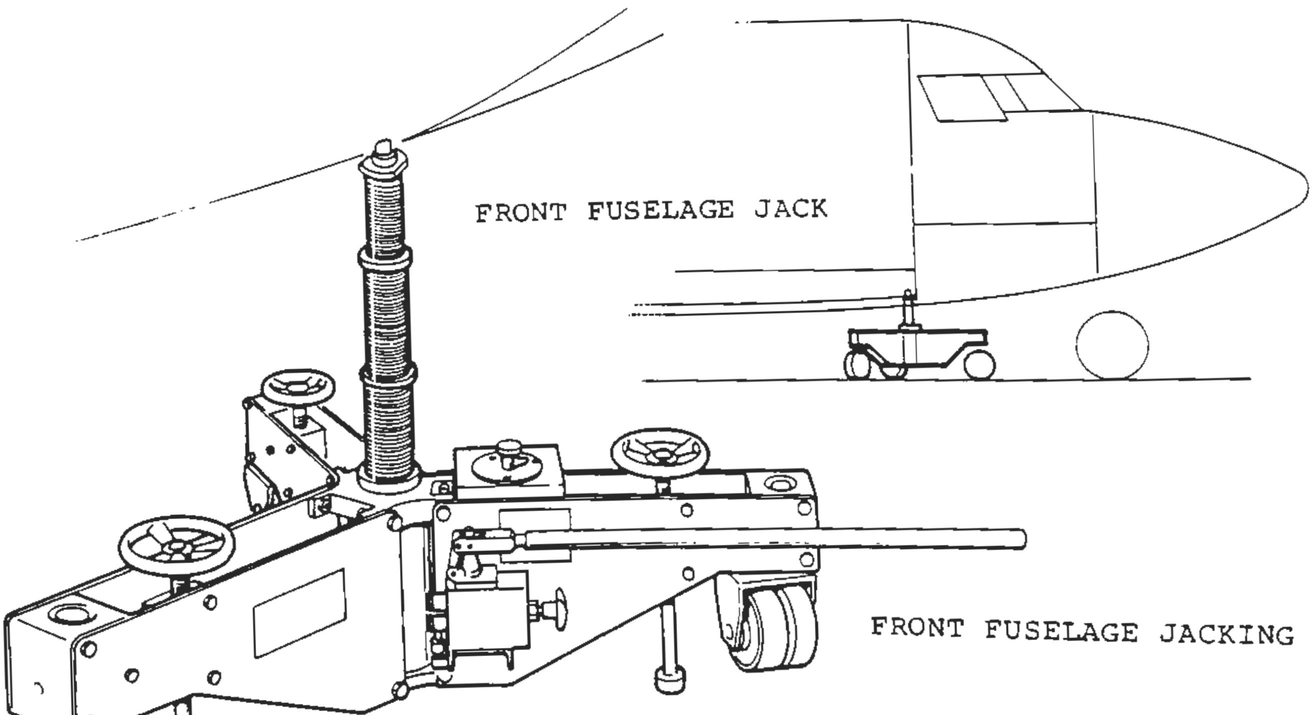

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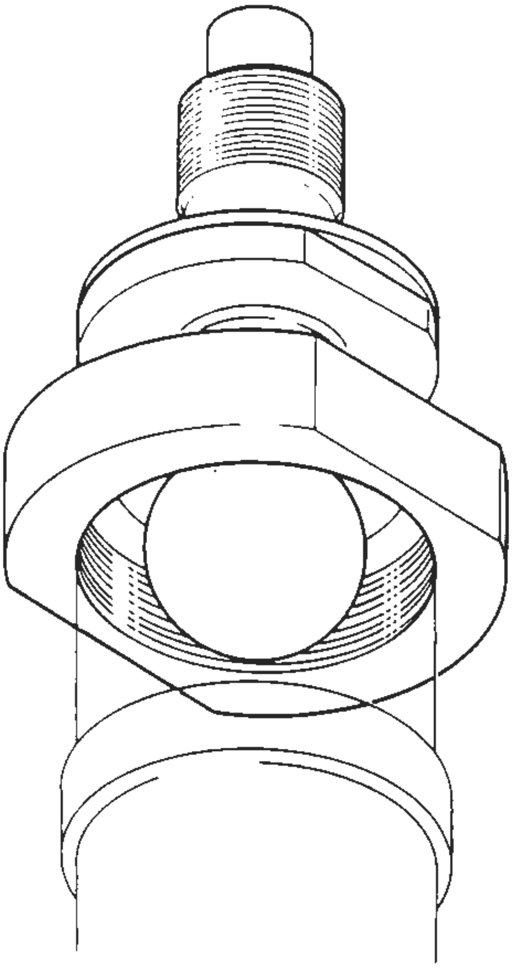

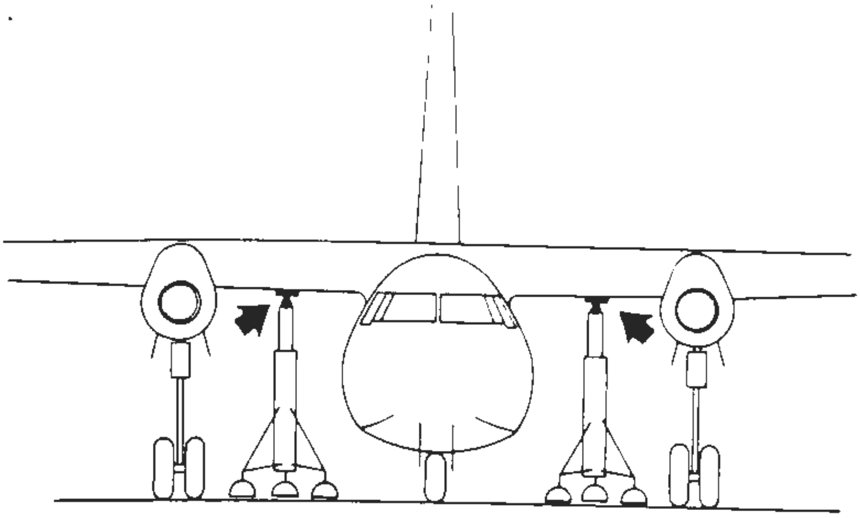

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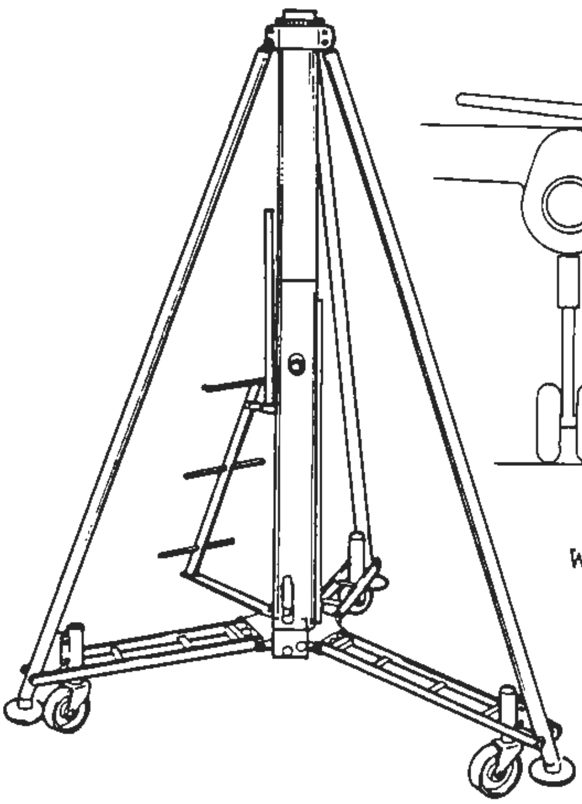
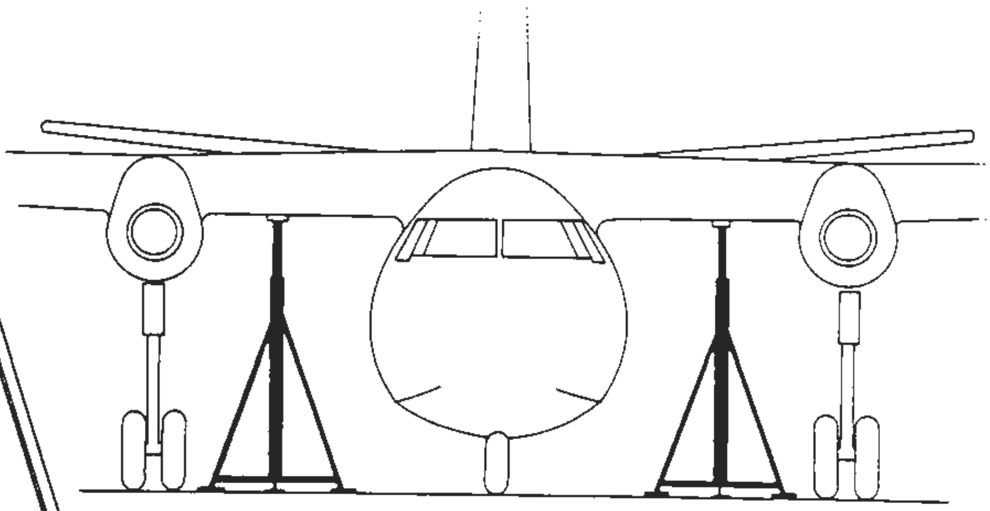
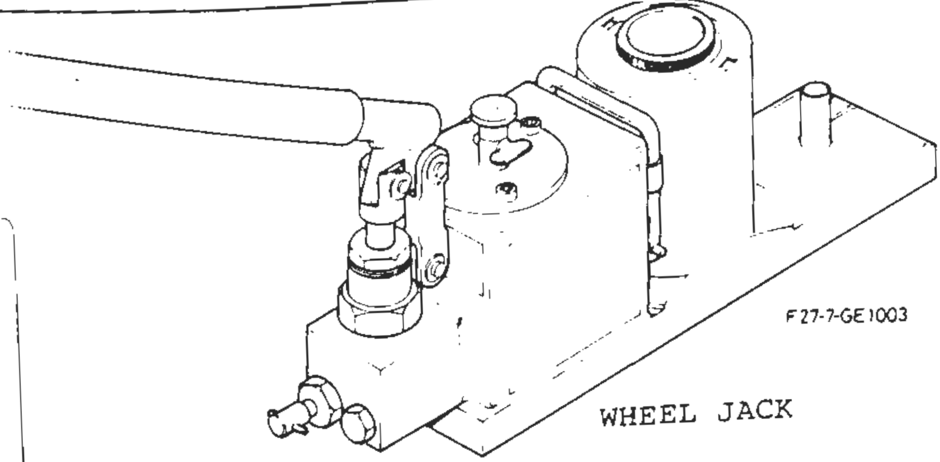
WING JACK PAD

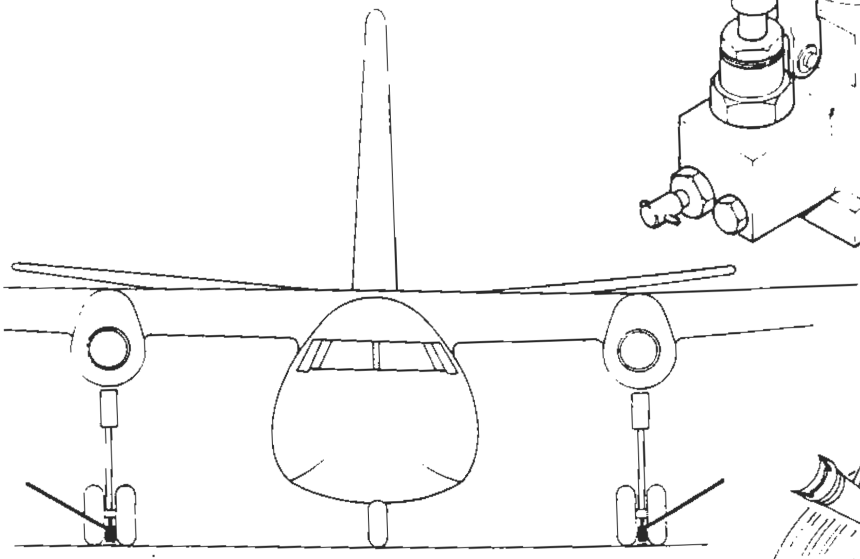


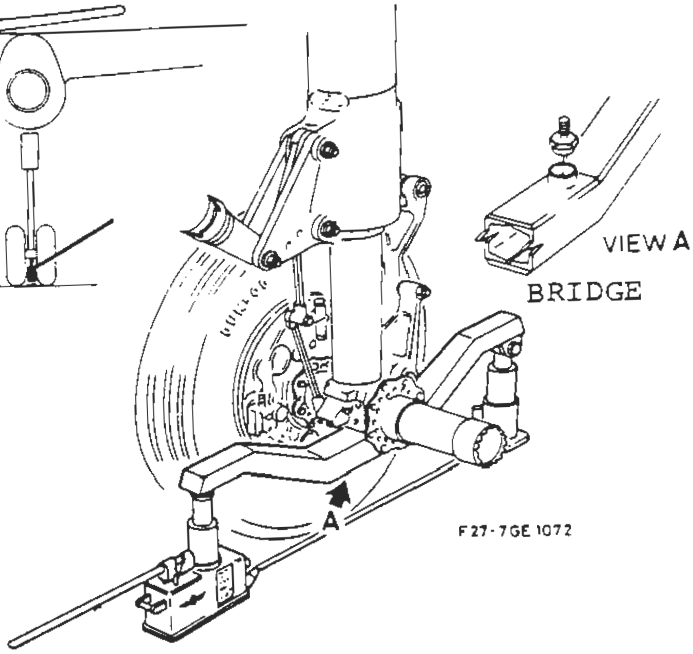


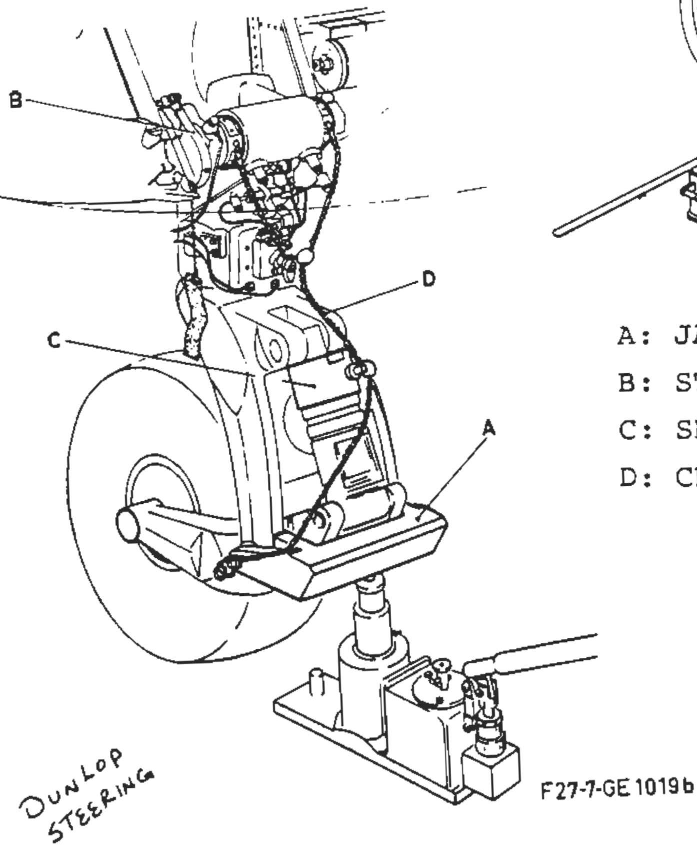
WING JACK

WING JACKING





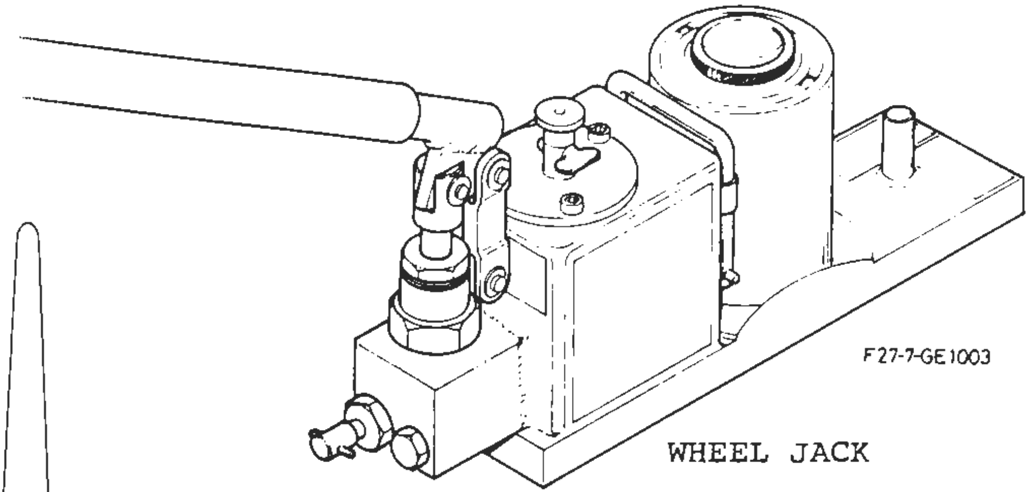




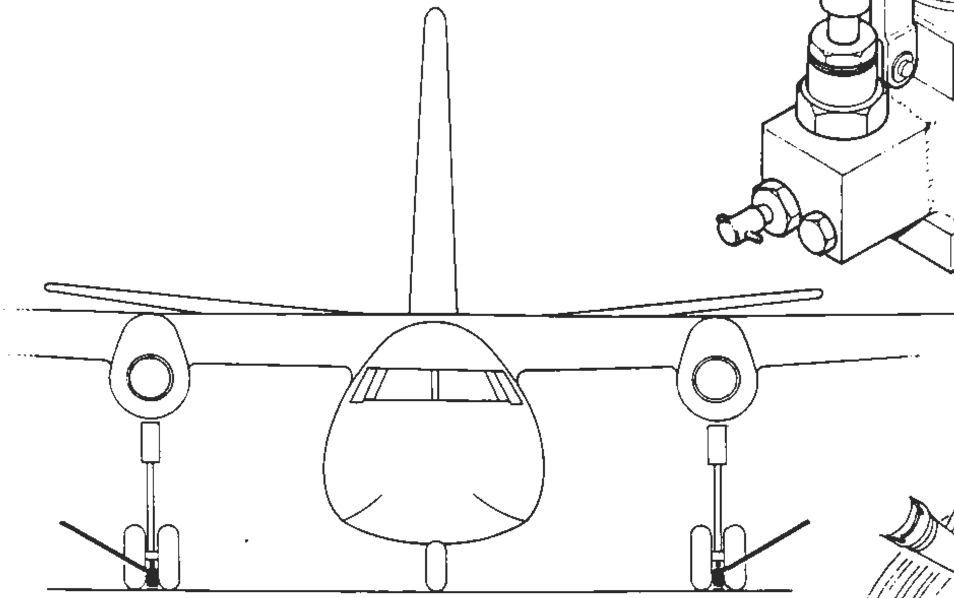
A: JACK SUPPORT
B: STEERING MOTOR LOCUS
C: SHOCK ABSORBER DISTANCE PIECE
D: CHAIN

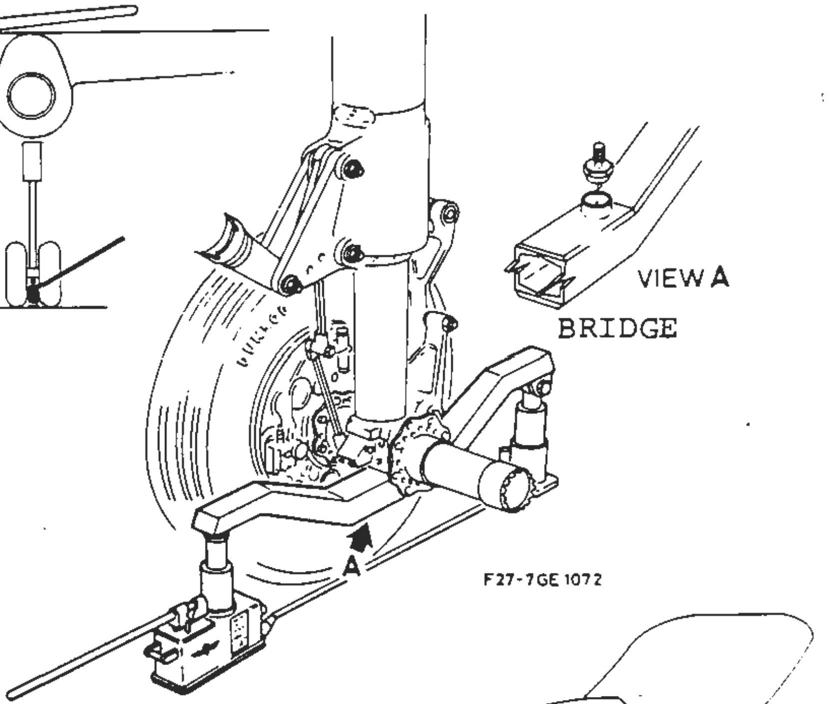
DUNLOP STEERING

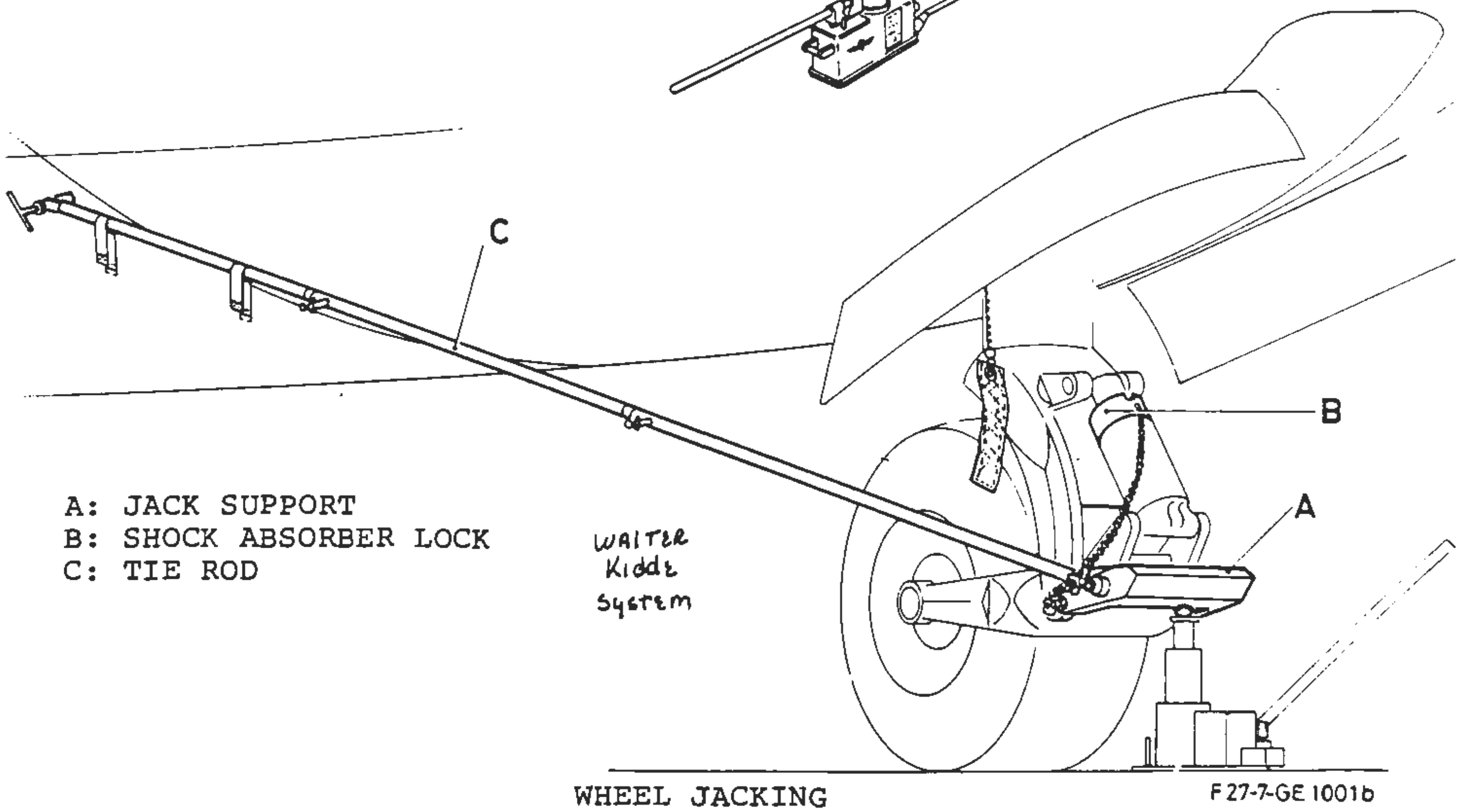
WHEEL JACKING



WHEEL JACK





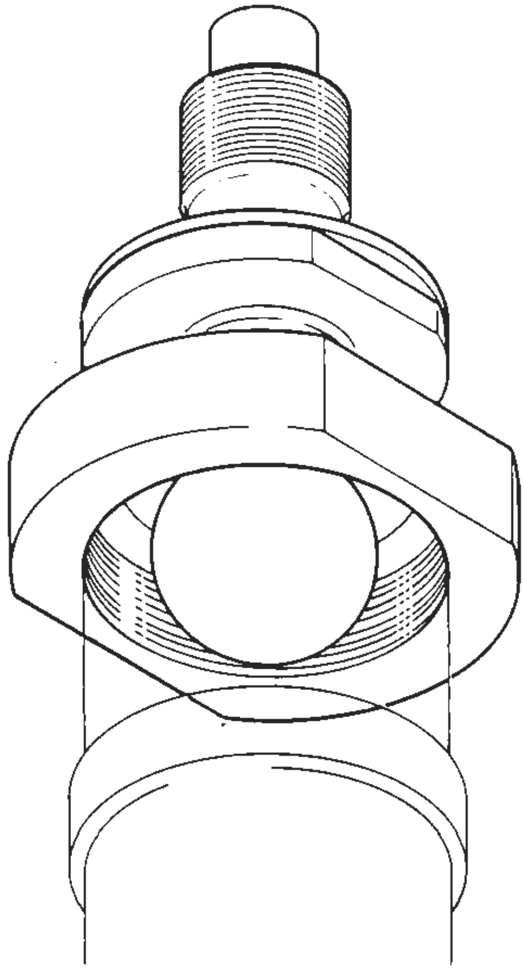


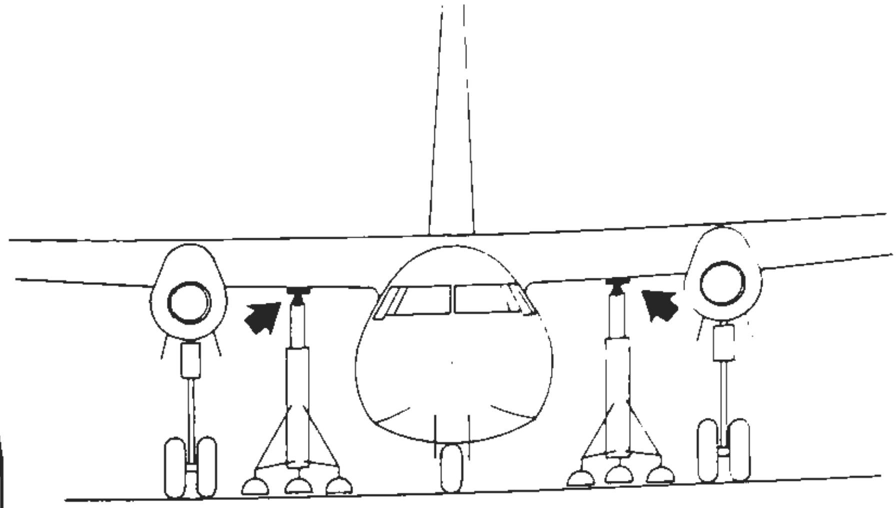
A: JACK SUPPORT
B: SHOCK ABSORBER LOCK
C: TIE ROD

WALTER Kidde System

WHEEL JACKING

F27-7-GE 1001b





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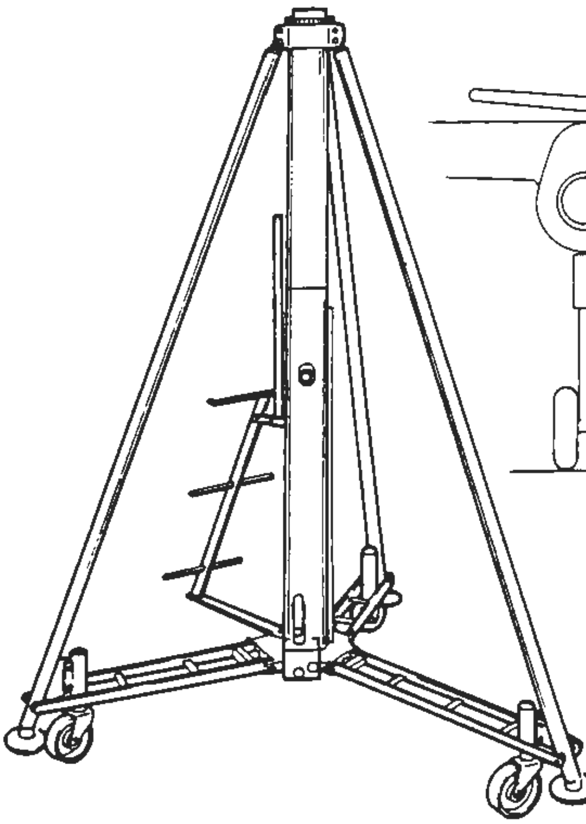
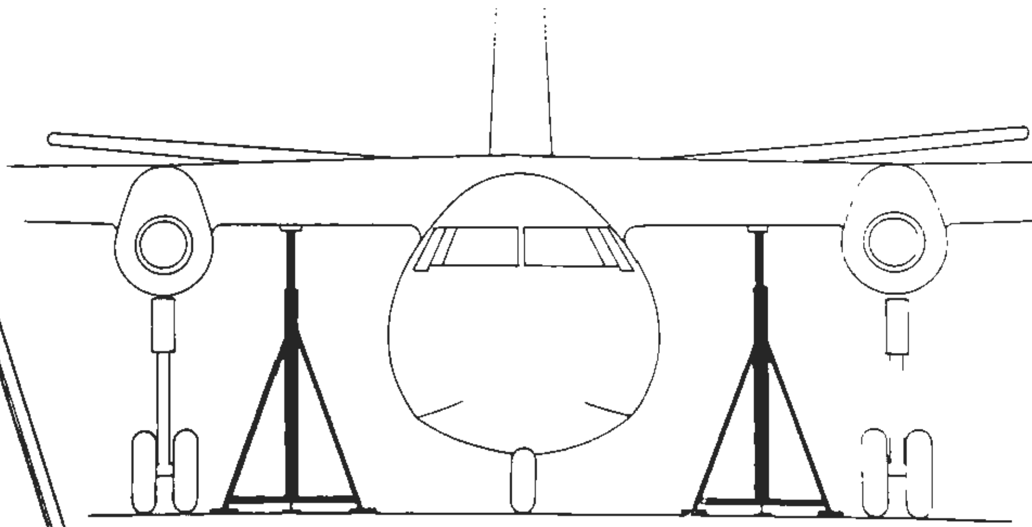
WING JACK PAD





WING JACK

WING JACKING

F 27-7-GE 1008

8. LEVELING AND WEIGHING

00. GENERAL

Leveling the aircraft is required for weighing, alignment checks, fuel tank calibration, major structural repairs etc.
Weighing is necessary to find the centre of gravity (the balance point) of the aircraft to fly it safely, or for reasons of poor performance.

10.0 LEVELING

Lateral leveling points are in the cockpit (sta. 3100) and behind the rear pressure bulkhead (sta. 17560 for Mk-600).
Longitudinal leveling points are located externally on the fuselage LH side at station 5835 and 6675.
To determine level attitude, a leveling bar and inclinometer are used at these points.

Leveling is normally performed by using the jacks installed under the jack points.

20.0 WEIGHING

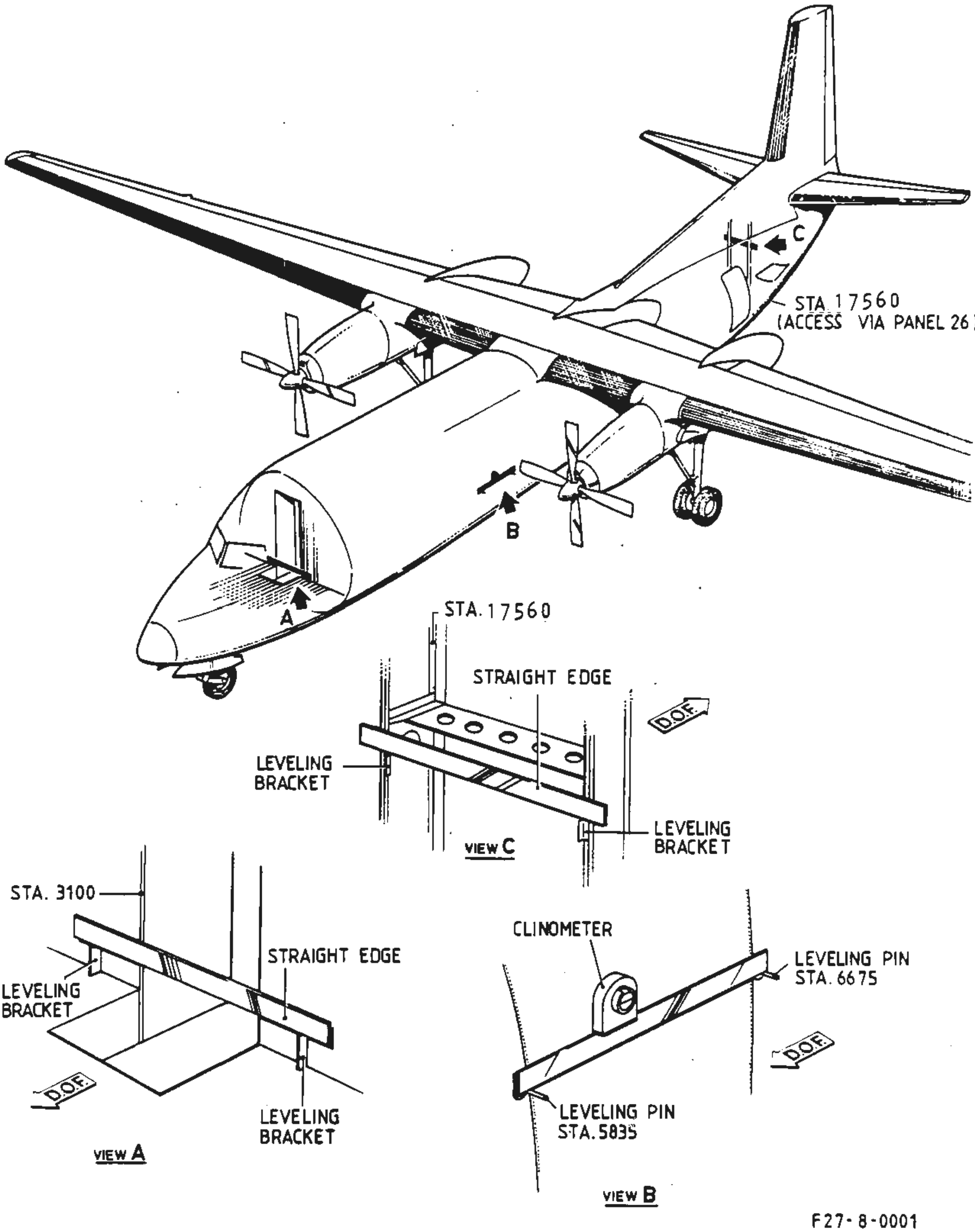
Mechanical weighing is achived by moving the aircraft onto weighing scales.
Longitudinal leveling is achieved by raising or lowering the nose gear weighing scales.

Electronic weighing is achieved by using cells between jack and adaptor.
The cells are connected to a weighing kit.

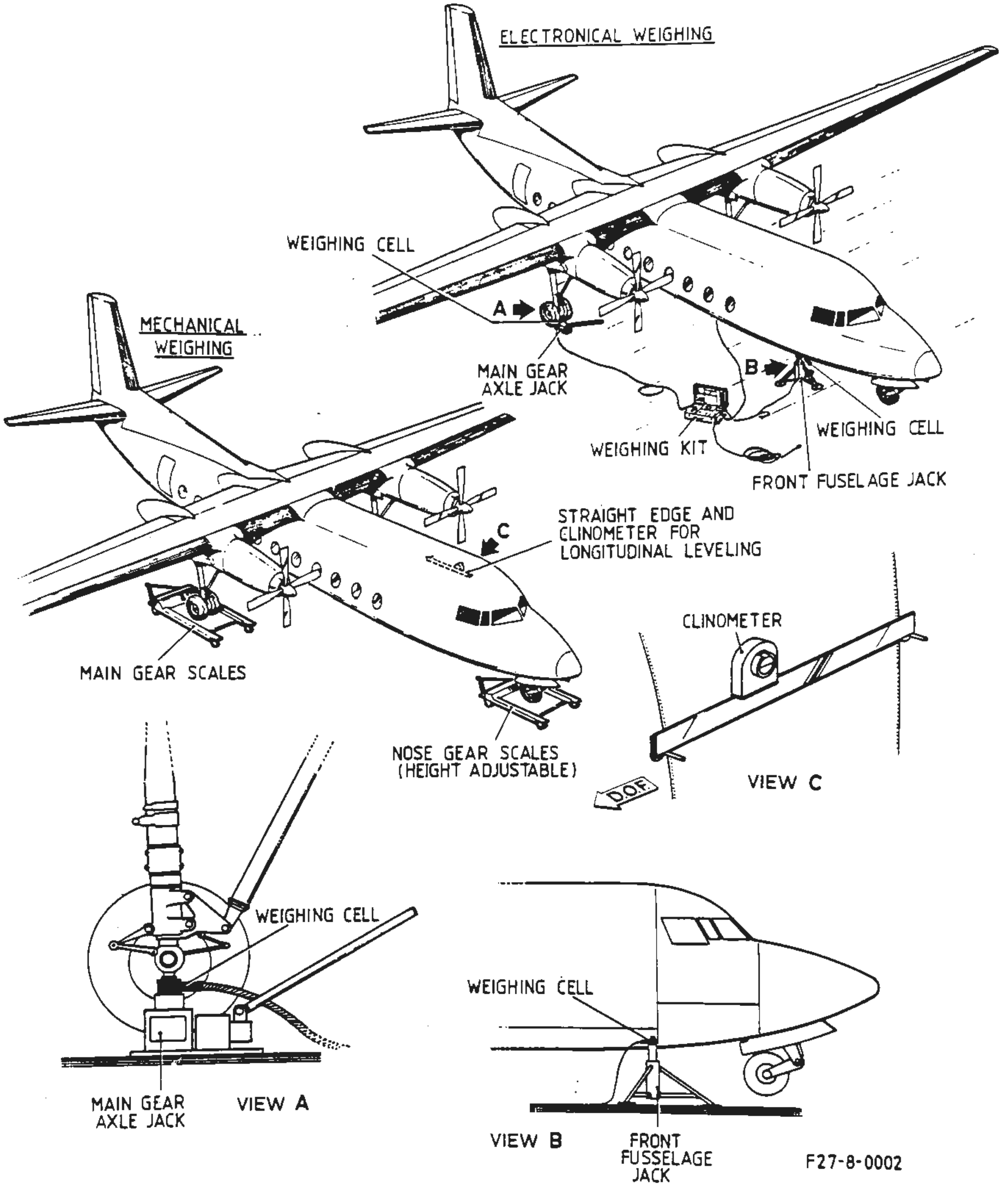
The weighing conditions are:

- aircraft equipment checked against weighing check list,
- all loose equipment stored in correct position,
- ground locks installed,
- all tanks and reservoirs, containing consumables, drained,
- all ground equipment disconnected,
- flaps up.

END


C
STA 17560
(ACCESS VIA PANEL 26)
B
A
STA. 17560
STRAIGHT EDGE
D.O.F.
LEVELING
BRACKET
VIEW C
LEVELING
BRACKET
STA. 3100
STRAIGHT EDGE
LEVELING
BRACKET
D.O.F.
LEVELING
BRACKET
VIEW A
CLINOMETER
LEVELING PIN
STA. 6675
D.O.F.
LEVELING PIN
STA. 5835
VIEW B
F27-8-0001

LEVELING


ELECTRONICAL WEIGHING
WEIGHING CELL
A
MAIN GEAR
AXLE JACK
B
WEIGHING KIT
WEIGHING CELL
FRONT FUSELAGE JACK
MECHANICAL
WEIGHING
C
STRAIGHT EDGE AND
CLINOMETER FOR
LONGITUDINAL LEVELING
MAIN GEAR SCALES
NOSE GEAR SCALES
(HEIGHT ADJUSTABLE)
CLINOMETER
D.O.F.
VIEW C
WEIGHING CELL
MAIN GEAR
AXLE JACK
VIEW A
WEIGHING CELL
VIEW B
FRONT
FUSSELAGE
JACK
F27-8-0002

WEIGHTING

9. TOWING AND TAXIING

00. GENERAL

Towing is normally done from the nose gear with the aircraft on hard, dry surfaces. Where mud, snow, or rough terrain conditions exist which create excessive towing loads, towing must be done from the main gears.
Under such conditions the forces required to move the aircraft may exceed the maximum permissible towing loads for the nose gear. Towing from the main gear can be done either in forward or rearward direction depending on the circumstances.

10.0 TOWING

10.1 Nose Gear Towing

Before towing the nose wheel steering mechanism must be disconnected by pulling a T-handle, located on the left-hand side of the nose gear pivot bracket. This T-handle is locked in the extended position by a special clamp. The nose gear can now turn a full 360 degrees. The towing vehicle must have a clutch with a torque value of minimum 900 kgf (2000 lbf).

Towing from the nose gear requires a forked tow bar, which is connected to the upper pivot-bracket shock-absorber attachment-lugs.

To protect the nose gear against excessive loading, a shear bolt is fitted to the tow bar. It is designed to shear at 3000 kgf (6600 lbf).
Towing with the nose wheel turned at angles greater than 68 degrees should be avoided because this results in scuffing of the main gear tires against the ground.

10.2 Main Gear Towing

The F27 has towing lugs mounted on the inboard side of the wheel axles. By using a steel cable bridle assembly, towing can be accomplished either forwards or backwards in mud, snow or on rough terrain.

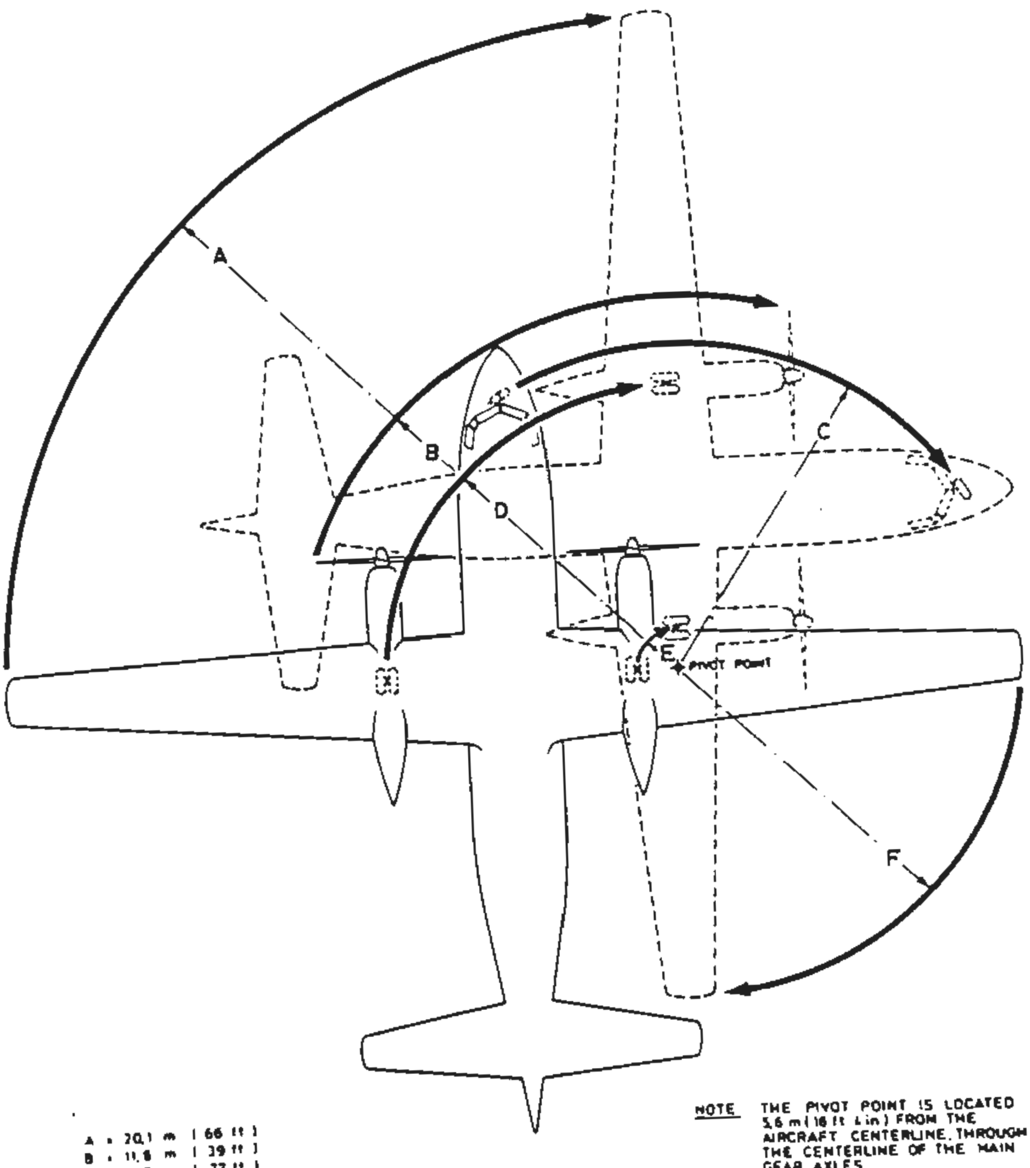
Towing at an angle of more than 30 degrees, inwards or outwards, from the main gear must be avoided.

10.3 Towing Loads

The maximum towing load at the nose landing gear is limited to 4350 kgf (9590 lbf) in forward and rearward directions. During towing, excessive impact loads on the nose gear must be avoided.

Permissible loads that may be applied to the nose landing gear vary depending on the turn angle of the nose wheel; as an example, with the nose wheel at 45 degrees from centre, a maximum load of 2155 kgf (4750 lbf) shall not be exceeded.

Each main gear supporting structure is designed to withstand a limit load of 3210 kgf (7075 lbf) applied to each towing lug, parallel to the ground, and 30 degrees each side of neutral.



A = 20,1 m (66 ft)
B = 11,8 m (39 ft)
C = 11,2 m (37 ft)
D = 9,2 m (30 ft)
E = 2,0 m (7 ft)
F = 8,9 m (29 ft)

NOTE THE PIVOT POINT IS LOCATED 5,6 m (18 ft 4 in) FROM THE AIRCRAFT CENTERLINE, THROUGH THE CENTERLINE OF THE MAIN GEAR AXLES

F 27-9-1148 b

TURNING RADII

10. PARKING AND MOORING

00. GENERAL

The aircraft should be parked on an apron with sufficient clearance fore, aft, and at the wing tips.

The parking area must be accessible to fire fighting and rescue equipment and servicing personnel.

During normal weather conditions it is not necessary to tie down the aircraft.
Normal precautions such as setting the park brakes, chocking the wheels, are enough. When parking for extended periods or when high wind velocities are expected, the aircraft should be tied down to approved mooring bases.

Protection covers must be installed whenever weather extremes are prevalent or for overnight periods.

10.0 PARKING

When parking the aircraft it should be positioned so that sufficient safety clearance is available. The parking brakes should be set (pull the park brake handle to lock, and gustlock engaged.

The landing gear ground locks must always be installed. Chocks must be placed fore and aft of main wheels.

Observe the following practices as closely as possible:

- The aircraft should be parked in the best possible position, so as to avoid sharp turns when moving out. Sufficient distance should be allowed, fore and aft, between the aircraft and other aircraft.

- The park brakes should not be set if the brakes are excessively hot. Allow the brakes to cool before setting.

- When unfavourable weather prevails, the aircraft should be headed into the wind, and protection covers fitted.

- If low temperatures prevail, precautions should be taken to prevent the aircraft tires from freezing to the ramp. The park brakes should not be set, as the brakes may freeze due to accumulation of moisture.

It is recommended to tie down the aircraft when the wind velocity exceeds:

- Wet or dry apron, 65 knots.
- Snow or ice, temperature below 0 degrees C, 35 knots.
- Snow or ice, temperature above 0 degrees C, 25 knots.

Refer to the maintenance manual chapter 10-00-00 page 1 for an itemized list of actions.

20.0 MOORING

Mooring procedures are used when the aircraft is to be parked for extended periods of time and when adverse weather or high winds are expected.

When the wind velocity is expected to exceed 90 knots, move the aircraft to a safe parking place.
When the gustlock is LOCKED, all flight controls are locked but separate locking clamps are provided for locking the ailerons, as movement of these may take place in high winds due to the spring-tab mechanism.

Mooring shackles are located on the forward and rear side of the main landing gear and at the rear side of the nose gear main fitting. The jack adaptors can also be used when provided with special mooring fittings.

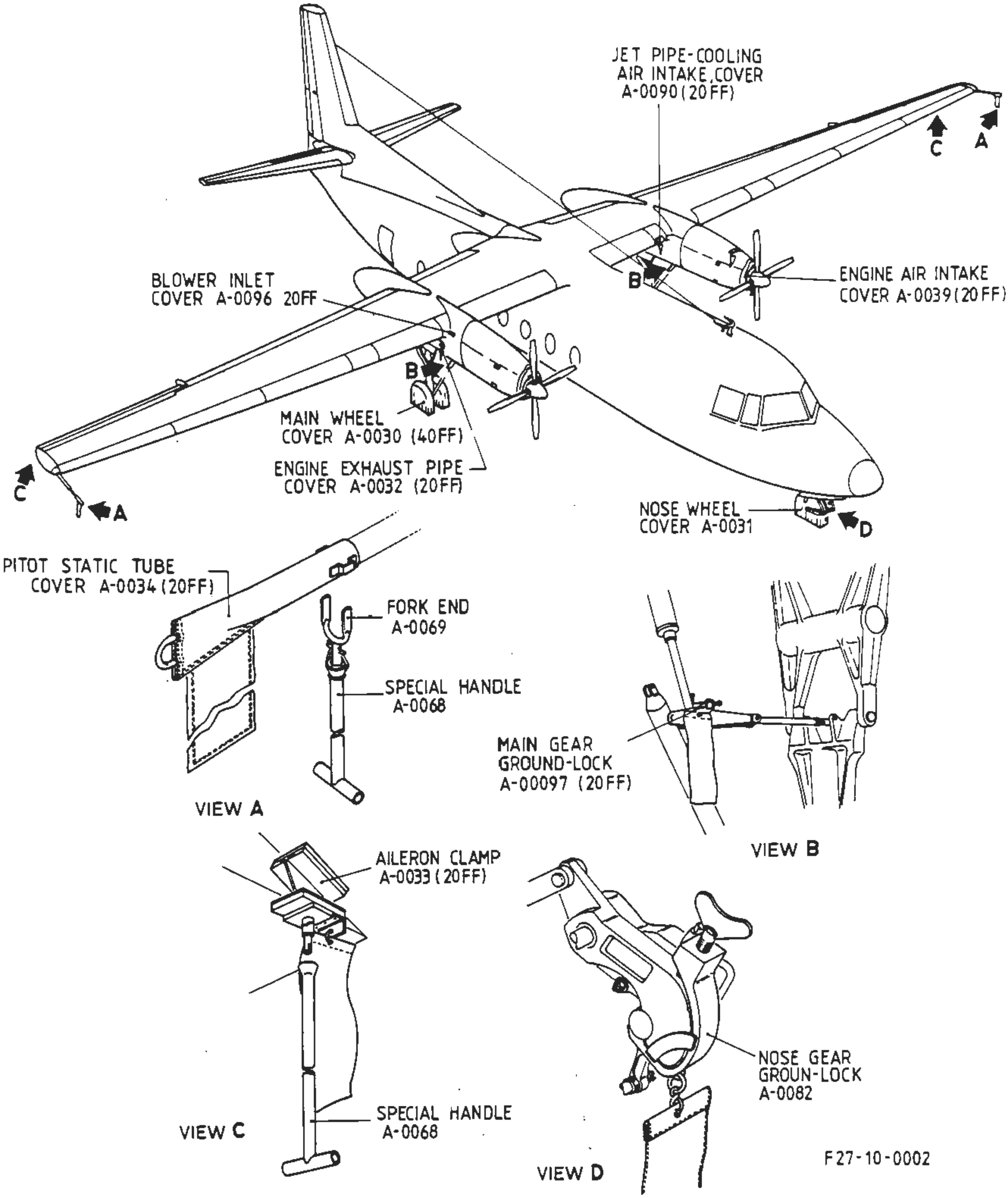
Aircraft tie down is accomplished by using mooring lines between the mooring shackles and ramp tie down points. Ensure that the mooring lines cannot slip through the shackles and, leave sufficient slack to prevent excessive stress due to shock strut extension and/or mooring line contraction.

Protection covers must be fitted to protect the engines, windshield, pitot-static tubes and wheels against weather extremes.

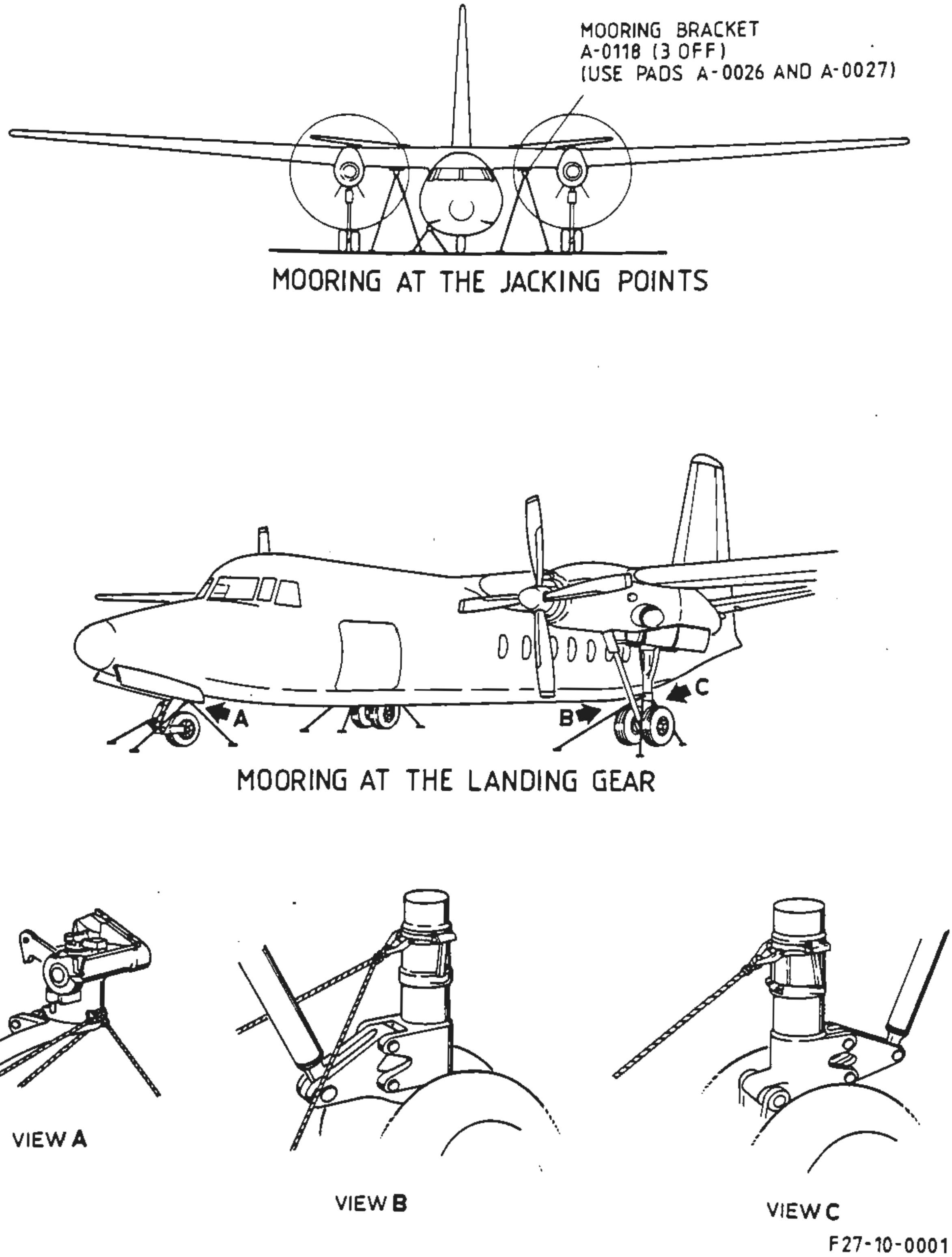
When the aircraft is moored for extended periods the tires should be inflated to a higher pressure and the wheels should be rotated every two weeks to prevent the tires from developing flat spots.

If the aircraft is parked or moored at a high ambient temperature, all doors (except the emergency escape exits and emergency door) and the cockpit sliding side windows should be opened to allow the heat to dissipate.

END



PROTECTION COVERS AND GROUND SAFETY DEVICES


MOORING BRACKET
A-0118 (3 OFF)
(USE PADS A-0026 AND A-0027)
MOORING AT THE JACKING POINTS
A
B
C
MOORING AT THE LANDING GEAR
VIEW A
VIEW B
VIEW C
F27-10-0001

MOORING

21 AIR CONDITIONING

Table of Contents

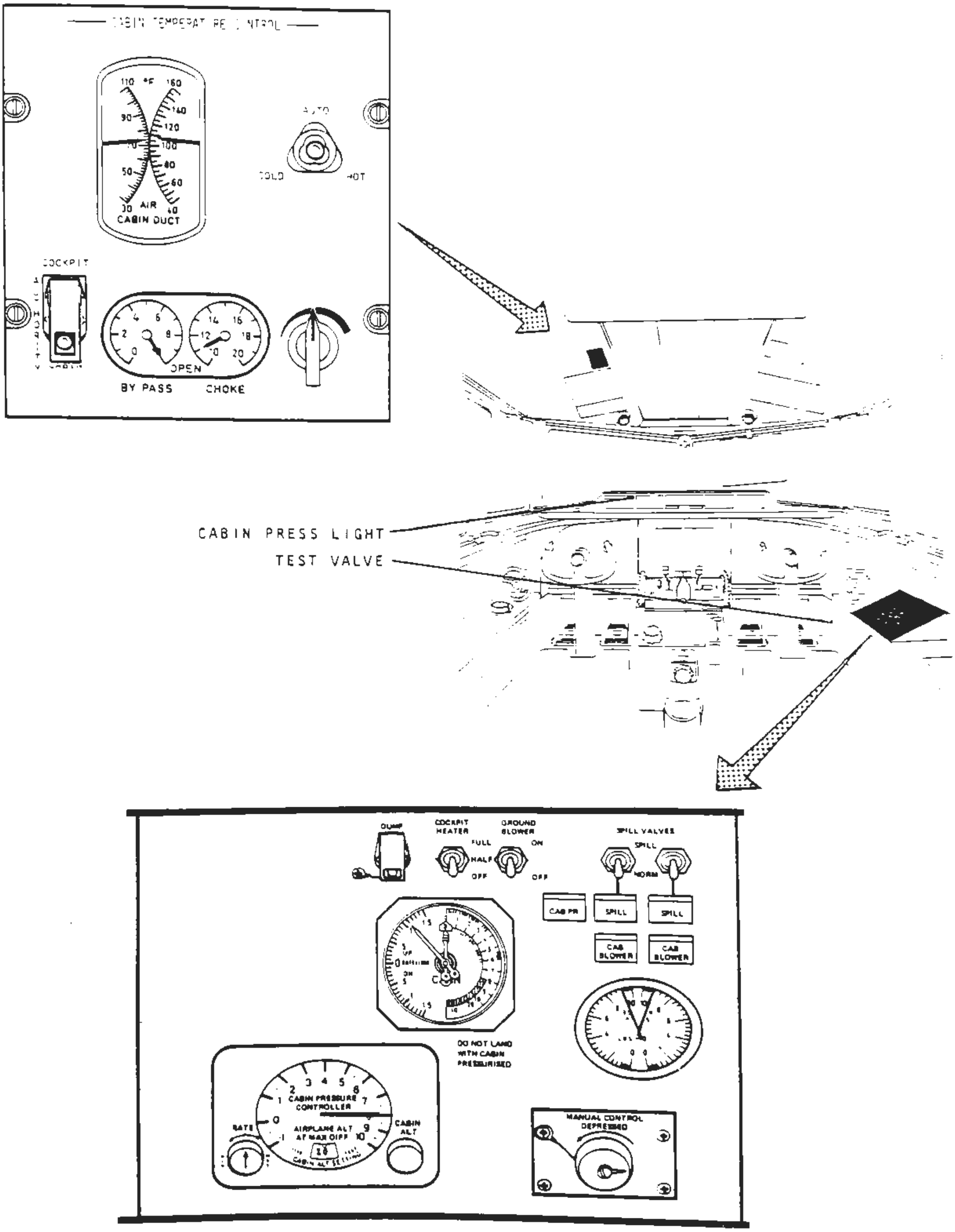
21.AIR CONDITIONING

00.0 GENERAL

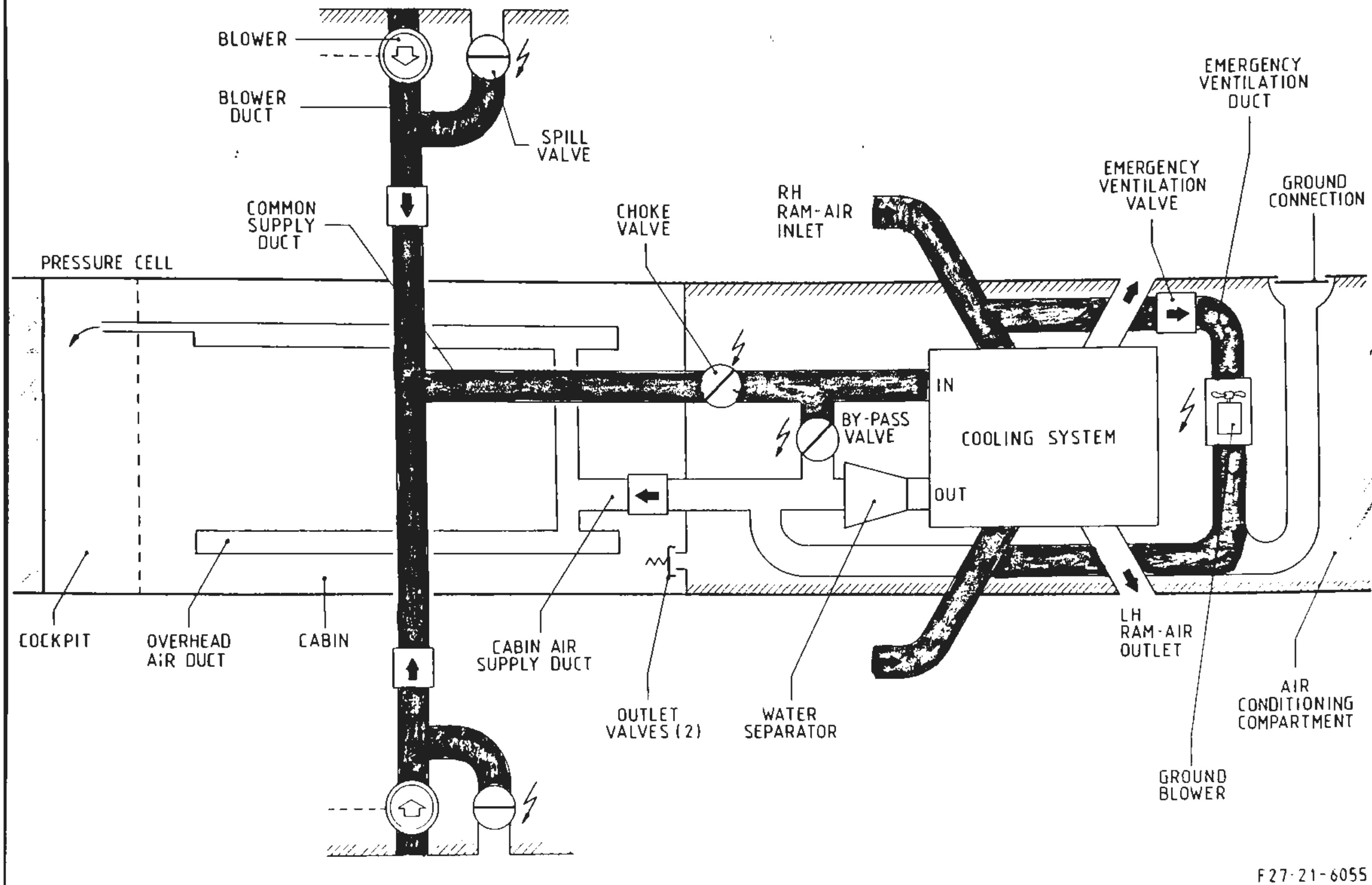
The air conditioning and pressurization system provides the necessary protection against the discomforts associated with flying at high altitudes and the high rates of climb and descent achieved by modern aircraft.
To provide this comfort the following requirements are necessary:
- air supply at a controlled flow,
- cabin air at a controlled pressure,
- cabin air at a controlled temperature.

Basically the air flow is supplied by two engine-driven blowers to an air conditioning system, which controls the temperature.
The conditioned air is ducted to the cabin and cockpit. The used ventilating air is circulated back to ambient via two outflow valves. The amount of cabin air, they release, is a function of the required cabin pressure.

END



CONTROLS AND INDICATIONS



AIR CONDITIONING AND PRESSURIZATION

10.0 AIR SUPPLY SYSTEM

During normal aircraft operation the air is supplied by two engine-driven blowers. In case of failure of the blower air supply, the aircraft can be ventilated by a flow of ram air entering the aircraft through an emergency ventilation valve. On the ground, without engines running, ventilation can be provided by an electric ground blower; conditioned air can be obtained from a ground air conditioning unit, connected to the aircraft ground connection.
The black boxes in the radio rack are ventilated by an electric radio rack blower.

The engine-driven blowers take in air from inlets, situated on each outboard side of the nacelle just in front of the wing leading edges.
A screen in each inlet prevents dirt from entering the system. From the blower outlet air pressure is supplied to pressure transmitters for indication in the cockpit. In each blower duct a silencer is installed to reduce the noise level. The noise is the result of the pulsating motion of the air supplied by the blower.

Downstream of each silencer are located electrically-operated spill valves. When operated they allow blower-supplied air to cycle back to ambient. Downstream of the spill valves are non-return valves, which prevent cross flow of air from one blower to another.
Downstream of the non-return valves, both blower ducts join on a common supply duct, which has a bigger diameter than the blower ducts, to contain the combined blower flow rates.
The common supply duct runs aft under the dorsal fin directly to the air conditioning compartment in the unpressurized rear part of the fuselage.
The air conditioning equipment takes care for the temperature control.

The temperature-controlled air, leaving the air conditioning system, the air from a ground air conditioning unit or the unconditioned ram air is supplied to the cabin through a duct running downwards along and then through the rear pressure bulkhead further to a T-connection under the cabin floor. Upstream of the T-connection is a non-return valve preventing depressurization of the cabin in case of leaks in the air conditioning equipment.

10.1 Blower

The blowers are rotary Roots-type, positive-displacement units mounted on the accessory gearbox. Each blower consists of a rotor case with a drive-end and top-end cover, ball and roller bearings, an oil metering unit, and the necessary seals. The light alloy rotor case is finned externally for strength and to aid in heat dissipation. Internally it forms two intersecting bores which accommodate the light-alloy rotors. These rotors are screwed to stub shafts which fit in bearings in the end covers. One rotor is driven by the accessory gearbox (master rotor) while the other (slave rotor) is driven by the master rotor via a helical spur gear on the rotor shafts. Air in- and outlet ports of equal areas are situated opposite each other in the rotor case.

When the rotors are rotating, air is drawn through the inlet port and

carried around the inside of the rotor chamber to the outlet port where it is discharged in the blower duct. There is no contact between both rotors or between rotors and casing. The contour of the rotors is designed such that in all positions there is only a very small gap between each other, thus sealing the blower.
No compression occurs inside the blower, but at its downstream side, the pressure builds up. The blower is capable of supplying about 20 pounds air per minute at 20,000-feet aircraft altitude and engine at cruising speed. The rotor speed is 0.535 times the engine speed.

Lubrication of the rotor bearings is provided by oil under pressure from the accessory gearbox via an oil metering unit. This metering unit, driven by the slave rotor shaft directs a limited amount of oil to the rotor top bearings. From there the oil is transferred to the lower bearings via an external hose. Scavenge oil drains back to the accessory gearbox.
Oil sealing arrangements within the blower ensure an oil-free air delivery under all circumstances.

Each blower has an overheat switch at the outlet side, which operates at 182 degrees C. When activated the relevant CAB BLOWER light on the RH side panel in the cockpit comes on. When the temperature decreases below 166 degrees the light goes off.

10.2 Blower Pressure Indication

Two synchro transmitters, connected via a flexible tube to the outlet of the blowers, are located against the fire wall of the accessory gearbox compartment.
They are installed on shock-proof mountings and convert the blower output pressure via AC signals to the dual blower pressure indicator on the RH side panel in the cockpit.

10.3 Silencers

Due to the pulsating motion of the air delivered by a blower a high noise level is generated in the blower ducts.
To reduce this noise a silencer is installed downstream of each blower. The silencers are located in the centre wing above the nacelle and accessible by removing a panel in the main wheel bay.

The silencer consists of an inner duct made of a porous metal called "felt metal" and a fibre-glass reinforced outer shell. The space between the outer shell and inner duct is divided into eight resonator chambers by seven metal partition walls welded to the inner duct. Sealing of the partition wall circumference against the bore of the outer shell is obtained by the installation of silicone rubber seals. Connection of the silencer to the ducting is by means of a rubber muff connection on the blower side and a Marman clamp and sealing ring at the other end.

10.4 Spill Valves

Each spill valve assembly consists of a butterfly valve operated by a DC electric motor. When the valve is in the open position the blower output

is dumped overboard through a duct ending in the nacelle outboard skin. The spill valves are located in the centre wing above the nacelle and are accessible by removing a panel in the main wheel bay.

The electric motor turns the actuator shaft via a reduction gear. The actuator shaft is coupled to the valve shaft, to which the butterfly valve is secured, by means of a serrated coupling. A cam on the actuator shaft serves to operate limit switches as the butterfly valve reaches either of the extreme positions. The limit switches are connected in the open and close winding circuits of the motor. De-energizing of the circuit releases a holding solenoid and engages a friction brake incorporated in the electric motor to prevent motor coasting.
To protect the electric motor and gear train from heat radiated by the cylindrical valve housing, a heat shield is fitted between the valve housing and the actuator assembly.
Connection of the spill valve to the ducting is by means of Marman clamps with a silicone rubber ring between the joint faces.

With the engines running and the SPILL VALVES switches on the RH side panel, in the NORM position the spill valves are closed, allowing the blowers to supply air to the air conditioning system.
If for any reason a propeller is feathered, the associated relay is energized causing the relevant spill valve to open. This prevents smoke, fumes or fire extinguishing agents from entering the cabin. The spill valves can also be opened by selecting the SPILL VALVES switches to the SPILL position. When a spill valve is full open, an amber SPILL light on the RH side panel in the cockpit is on.

10.5 Non-return Valves

Double-flap springloaded-type non-return valves are located in the ducting downstream of each silencer and are accessible through panels at the top centre wing fillet.
When air is flowing in the normal direction the flaps are pushed open by the airstream and remain open. Should the supply of air cease or, if one spill valve is open, the flaps will close to maintain pressure on the downstream side and prevent return flow. The valves are connected to the duct with Marman clamps and a silicone rubber gasket between the joint faces and are accessible through large panels at the top centre wing fillet.

10.6 Air Conditioning Ground Connection

Ventilation, heating and cooling of the cabin without engines running can be obtained from a ground air conditioning unit, which can be connected to the air conditioning system via a ground connection located at the RH side of the rear fuselage.

The connection consists of a metal housing, duct coupling and a shut-off door with latches. The door is hinged to the housing and sealed against a flange by a synthetic rubber ring cemented to the door. The flange itself is riveted to the fuselage skin.
A latch mechanism fitted on the door, can be externally actuated by a small handle which, on closing of the valve, can be locked by a spring

plate. Two latches are unlocked by turning the handle counter-clockwise about half a turn, until the latch arm hits a stop. With the latches released, the door can be pushed into open. Two slots, according to NAS 401 specs, are located in the fuselage skin for the connection of the ground air conditioning unit hose.

10.7 Ground Blower

The ground blower consists of an electrcically-driven fan. Stationary guide vanes between the duct and stator prevent the air from rotating. A radio-noise suppressor is fitted externally to the rear of the motor.
The blower is installed in the emergency ventilation duct so during operation it draws air from the RH ram-air intake via the emergency ventilation valve.

Electrical power is fed to the ground blower motor via the ground blower contactor. This contactor is controlled by the GROUND BLOWER switch on the RH side panel in the cockpit and the RH landing gear shock strut switch which automatically stops the ground blower as soon as the aircraft is airborne.

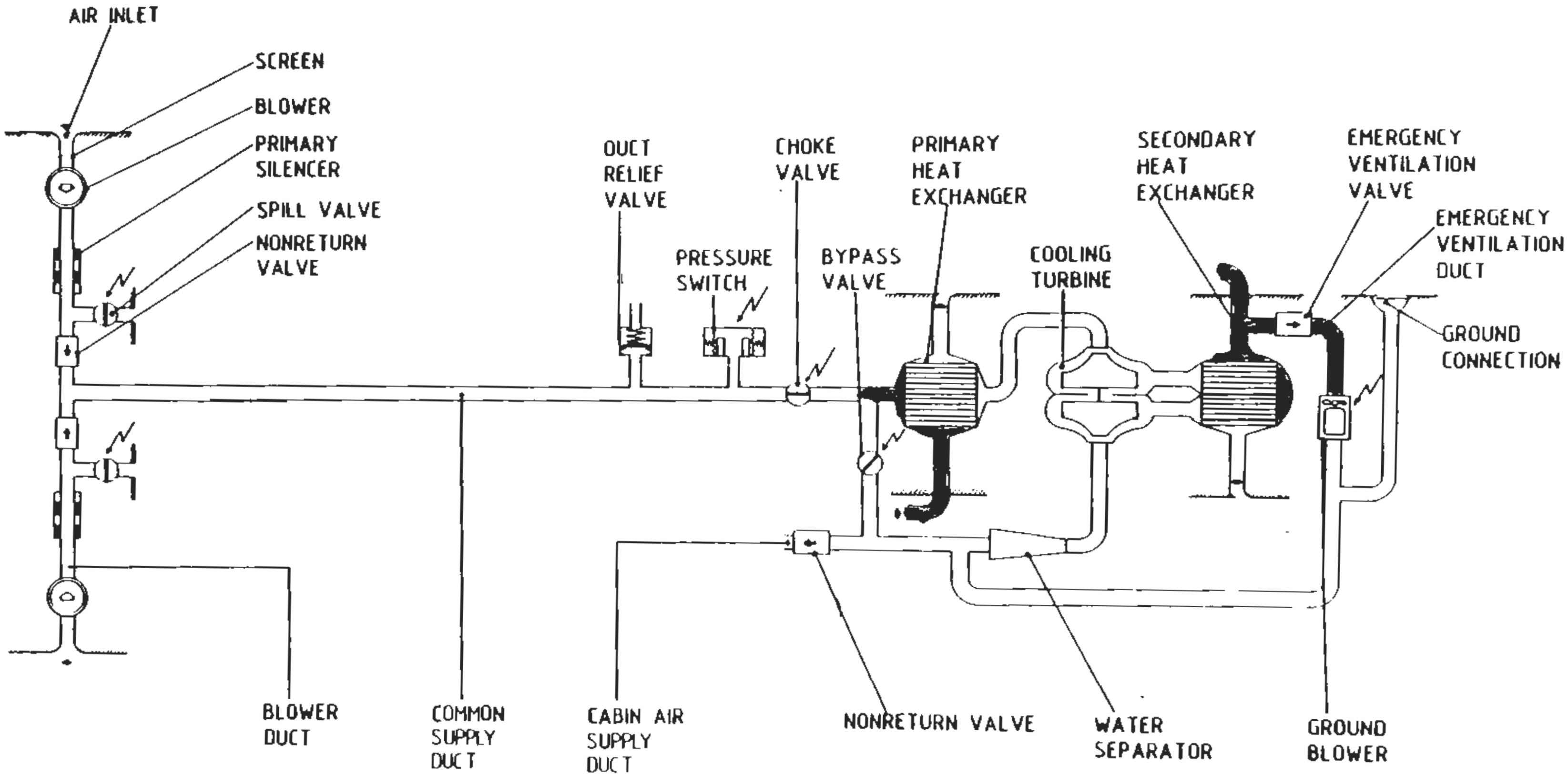
10.8 Emergency Ventilation

In case the normal air supply fails, or the blower output is dumped by opening the spill valves, ram air will be automatically introduced to the cabin through an emergency ventilation valve. The valve is fitted in the emergency ventilation duct which is tapped from the RH ram-air intake of the secondary heat exchanger.
The emergency ventilation valve opens as soon as the ram air pressure prevails over cabin pressure. The temperature of the emergency ventilation air supplied to the cabin can now of course not be controlled, however an extra cockpit heater can be operated in the normal way.

10.9 Radio Rack Cooling

The electronic equipment in the radio rack are air cooled. The air is directed into the radio rack through louvres in the rack structure. A blower brings the air, via the electronic equipment and through an air duct, underneath the cabin floor.
Flexible hoses are used to connect the air duct to the individual mounting trays on the radio rack shelves. The blower starts to operate when master radio switch 1 is operated.

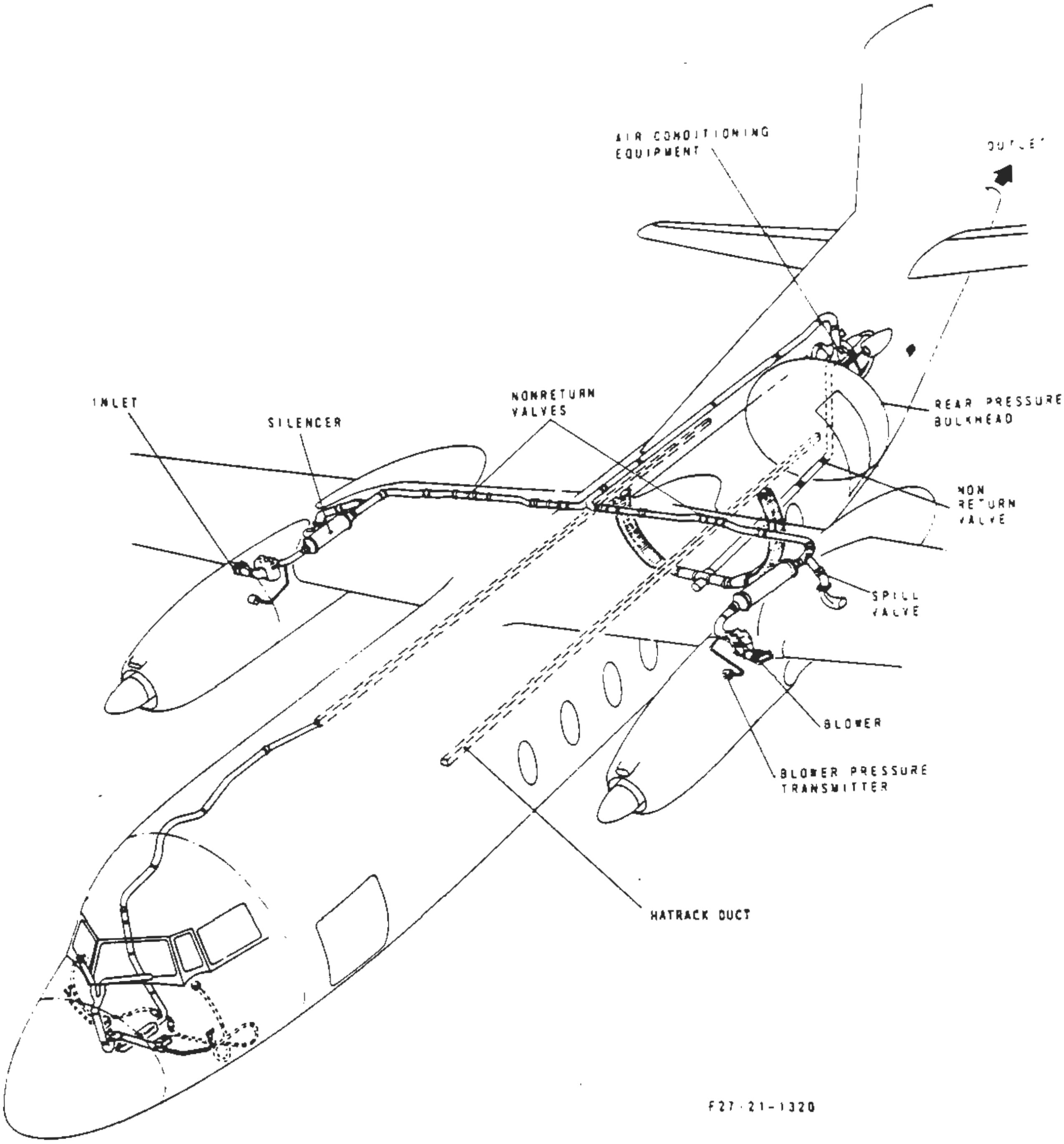
END



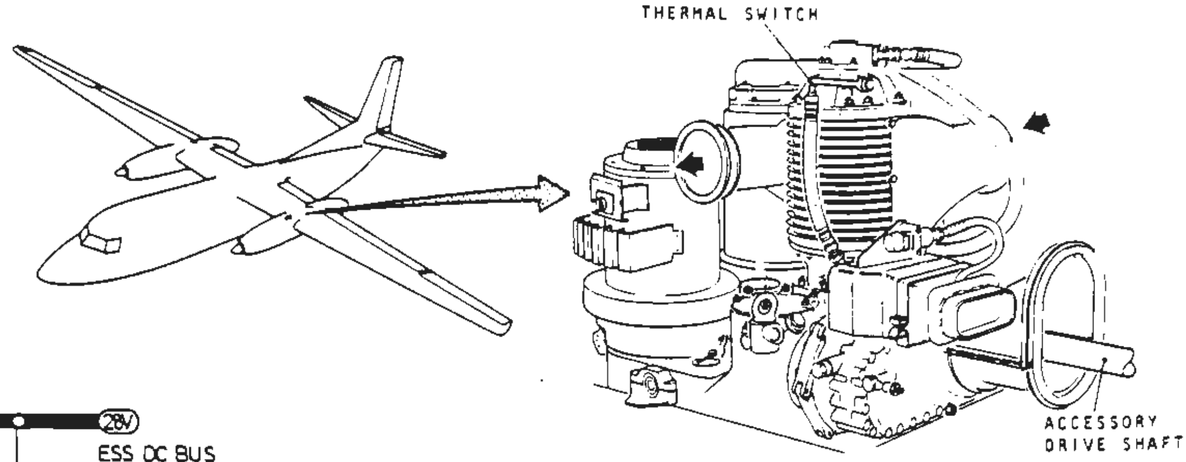
F27-21-0044

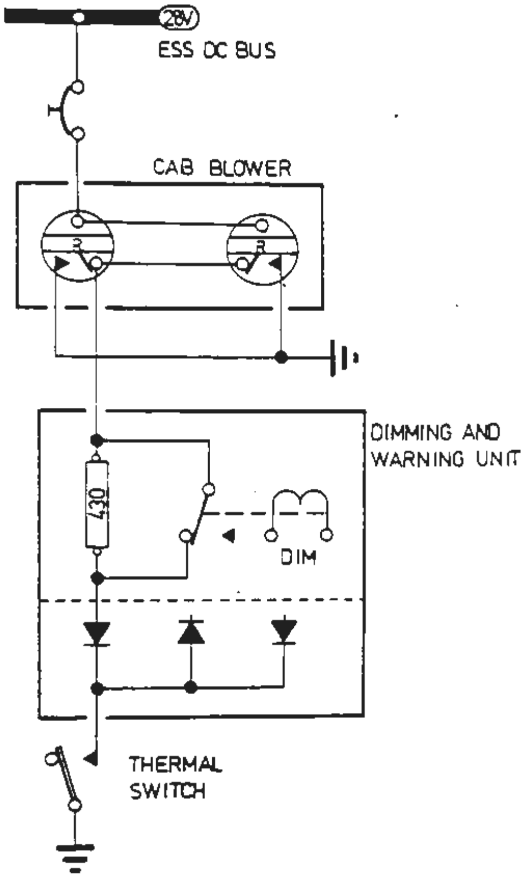
21.10
Fig.1

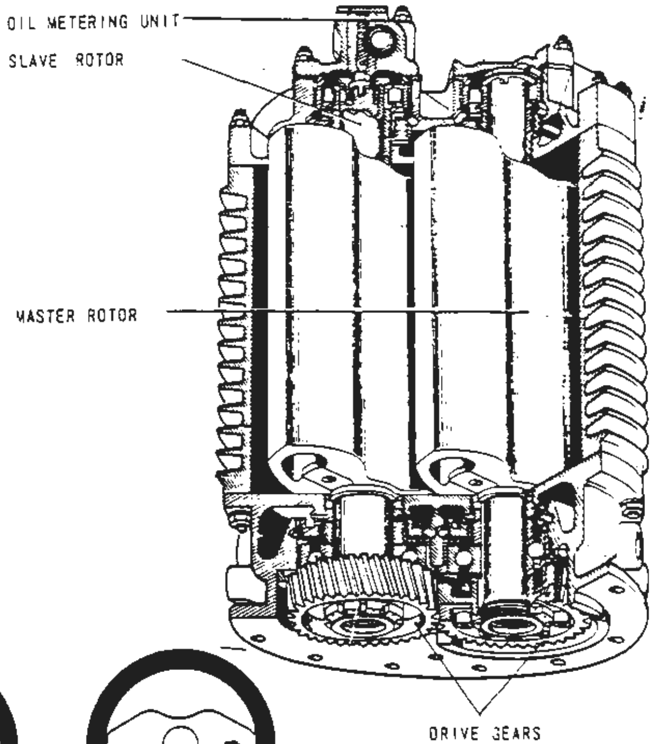
AIR SUPPLY SYSTEM

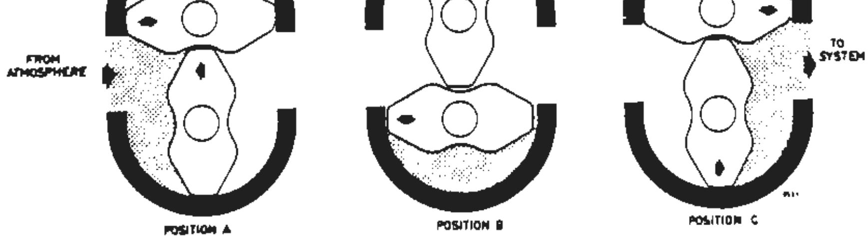


AIR SUPPLY SYSTEM AND DISTRIBUTION

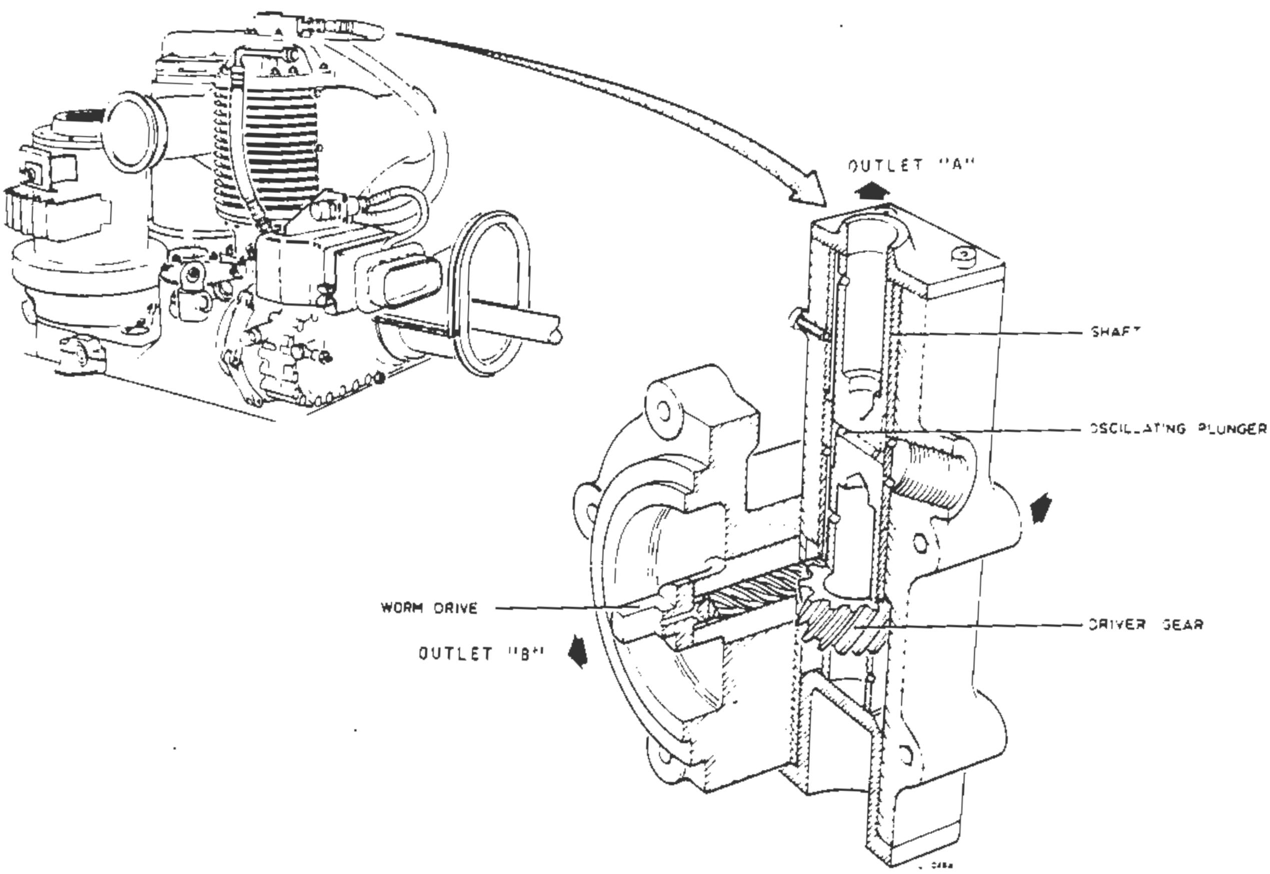

THERMAL SWITCH
ACCESSORY DRIVE SHAFT

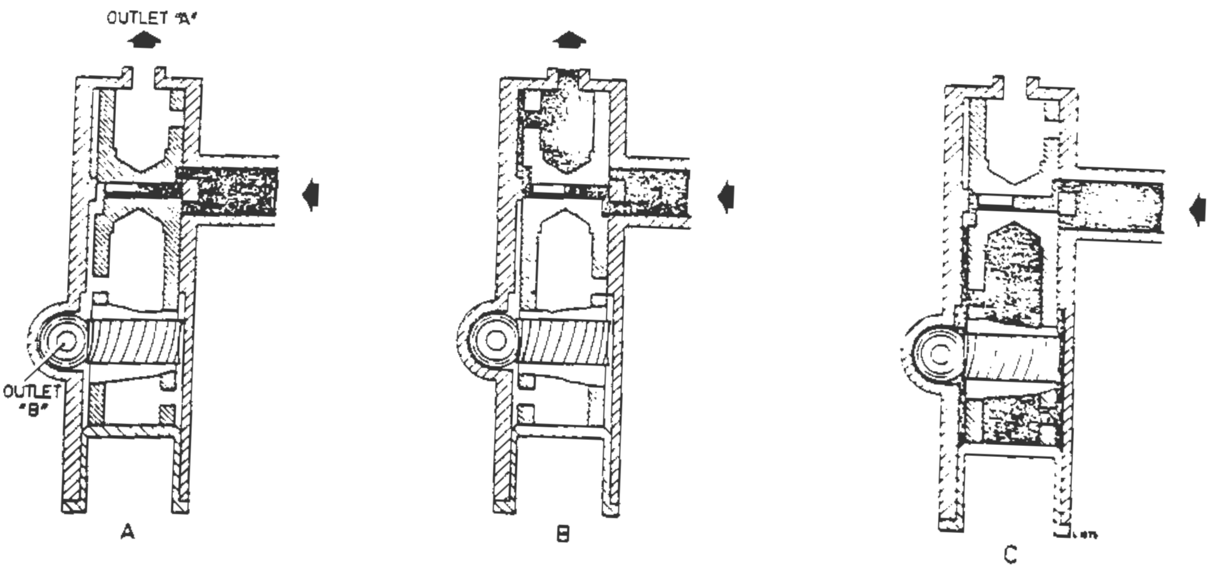

28V
ESS DC BUS
CAB BLOWER
DIMMING AND WARNING UNIT
430
DIM
THERMAL SWITCH


OIL METERING UNIT
SLAVE ROTOR
MASTER ROTOR
DRIVE GEARS

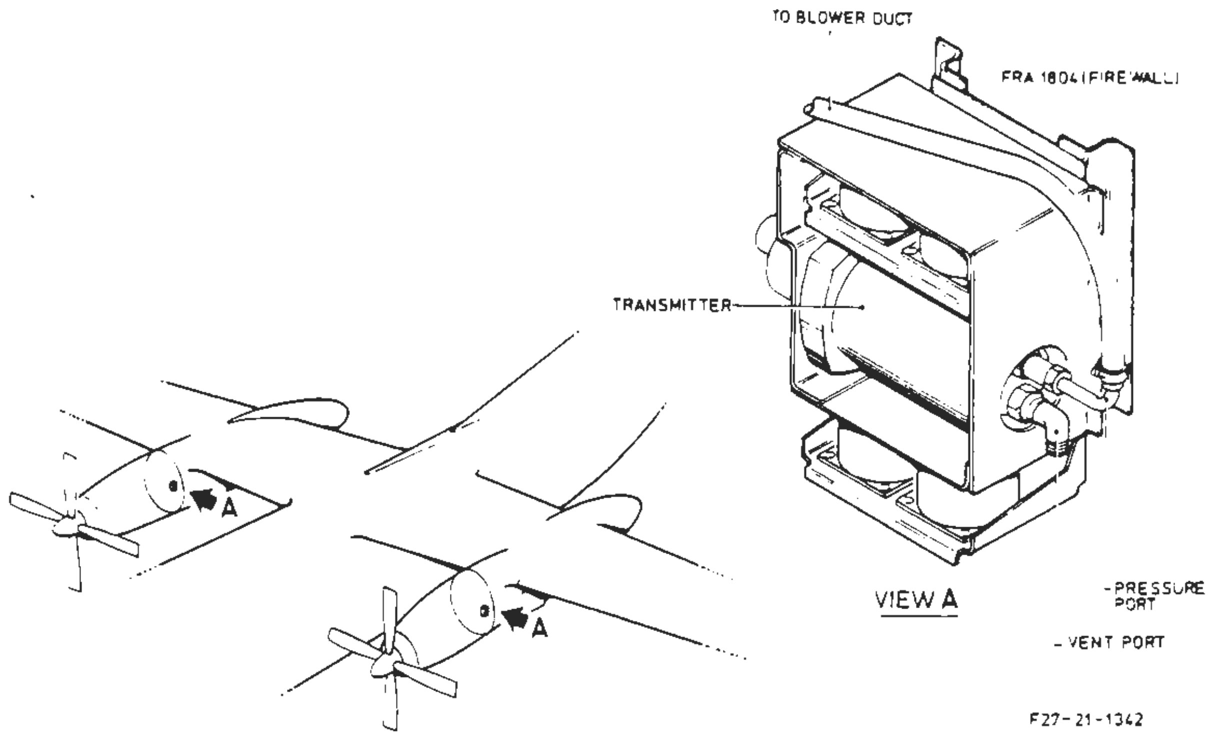

FROM ATMOSPHERE
TO SYSTEM
POSITION A
POSITION B
POSITION C

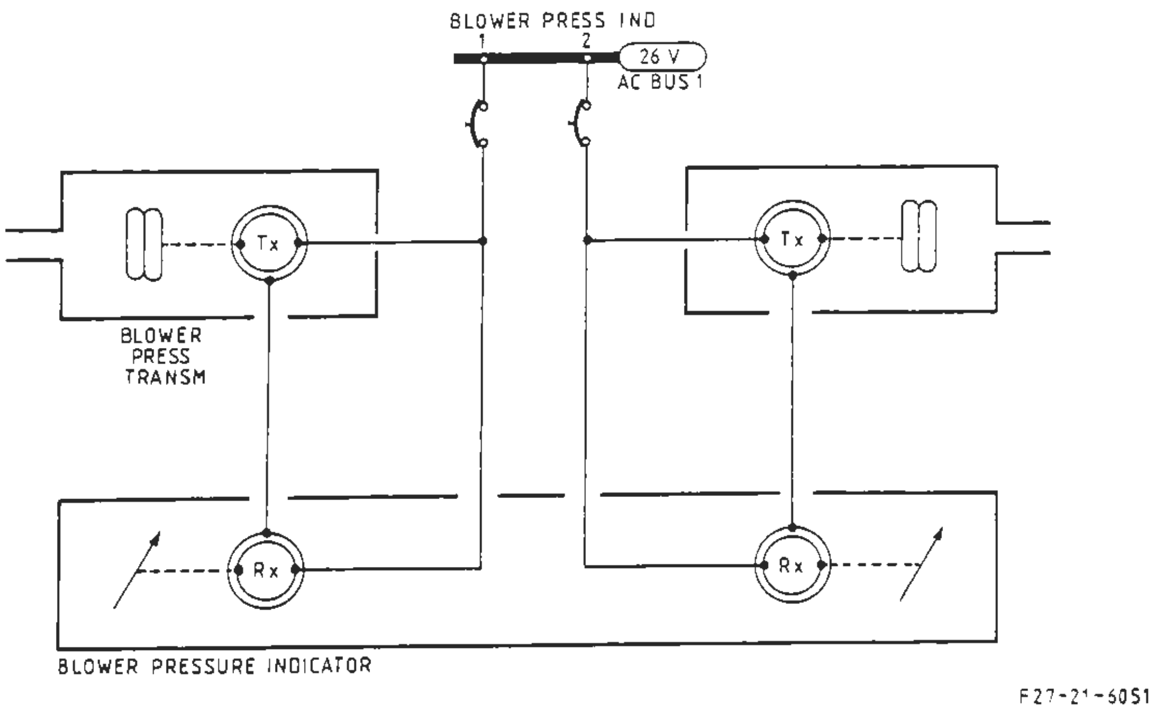
BLOWER



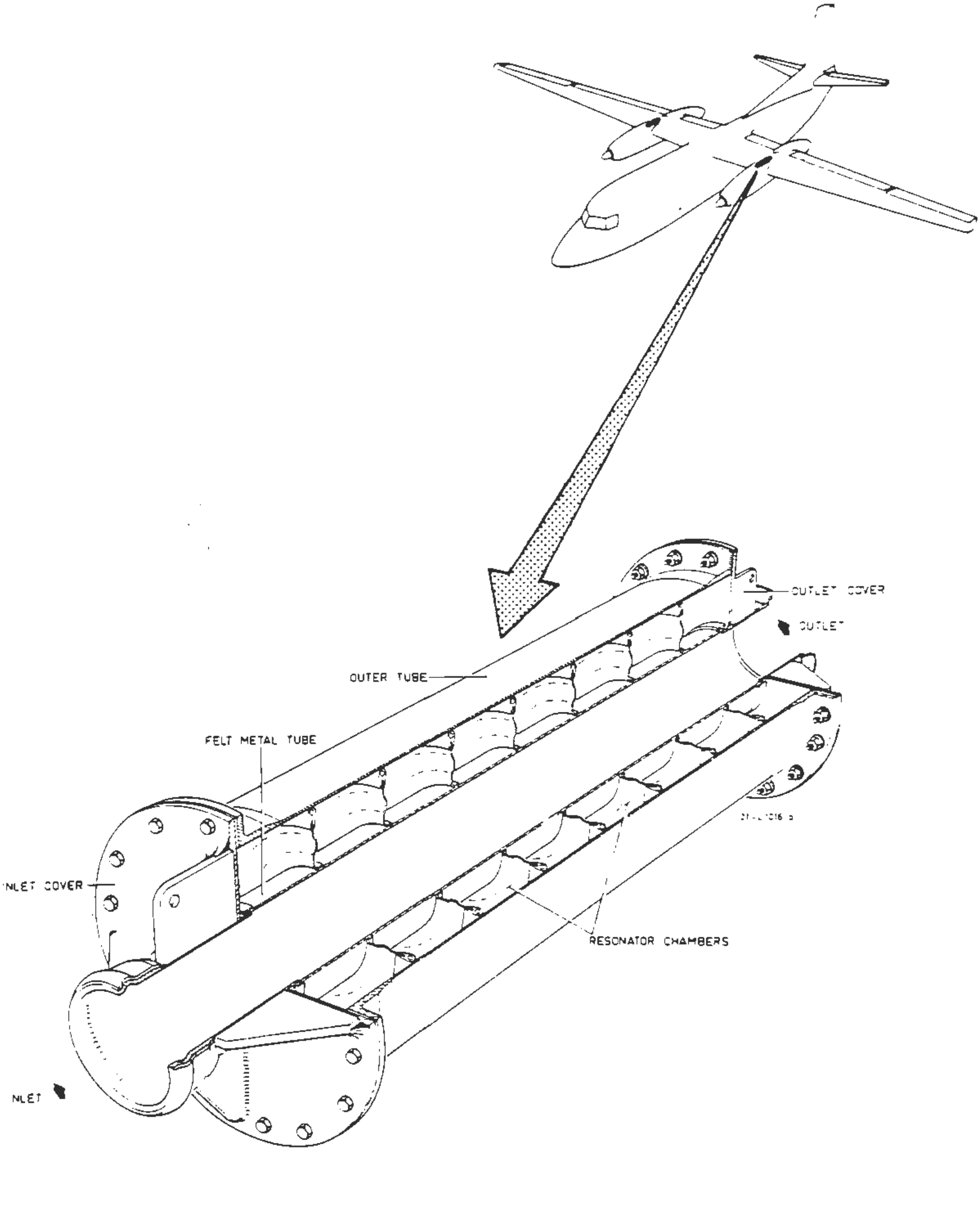


OIL METERING UNIT



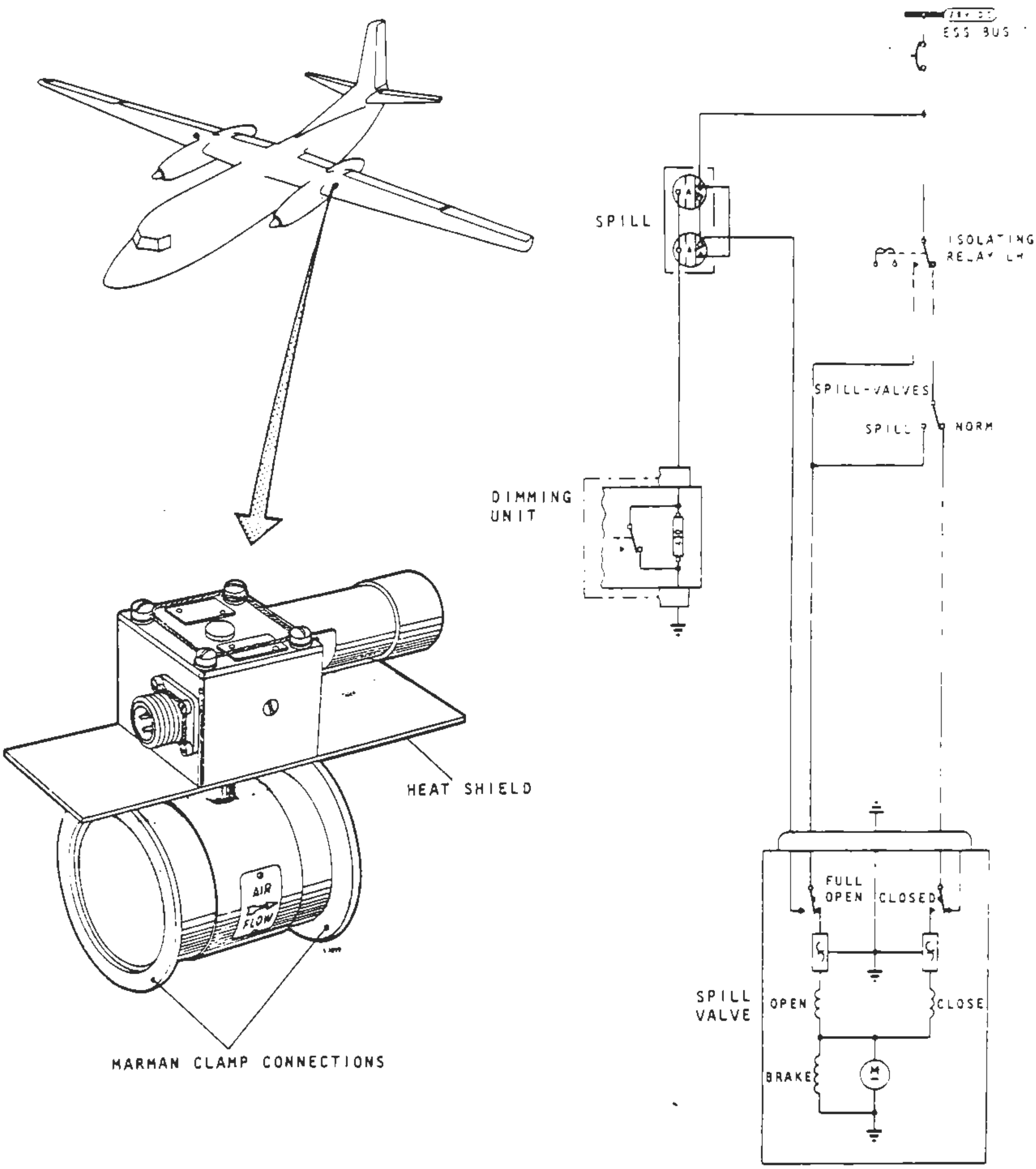


BLOWER PRESSURE INDICATION

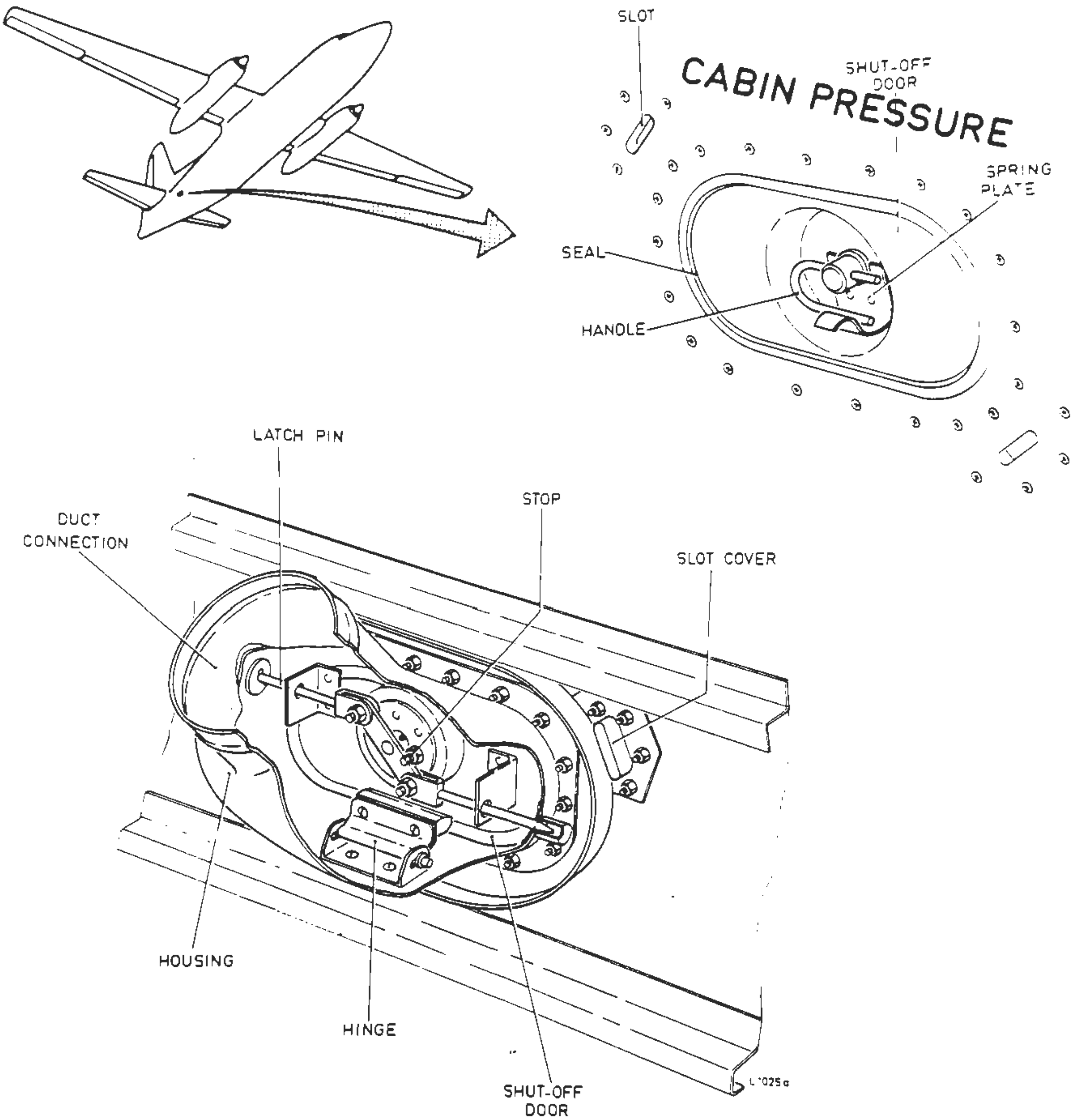


SILENCER

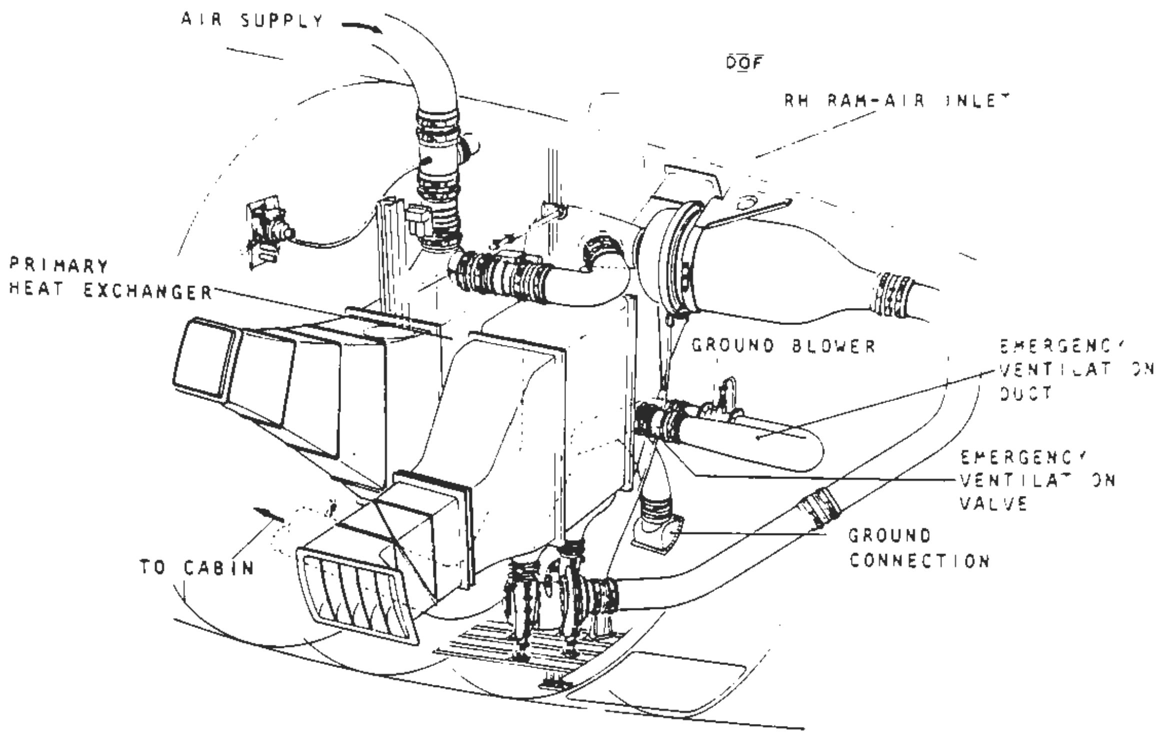
CODE 4

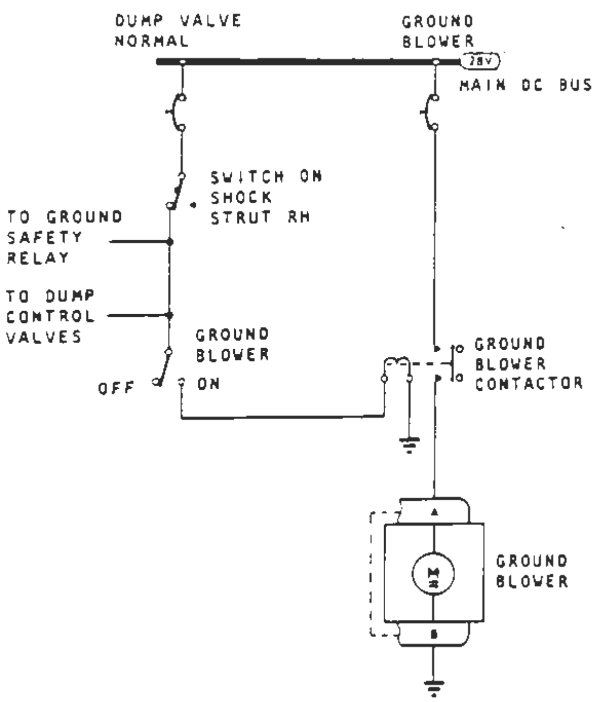

ESS BUS
SPILL
ISOLATING
RELAY LH
SPILL-VALVES
SPILL
NORM
DIMMING
UNIT
HEAT SHIELD
AIR
FLOW
FULL
OPEN
CLOSED
SPILL
VALVE
OPEN
CLOSE
BRAKE
M
MARMAN CLAMP CONNECTIONS

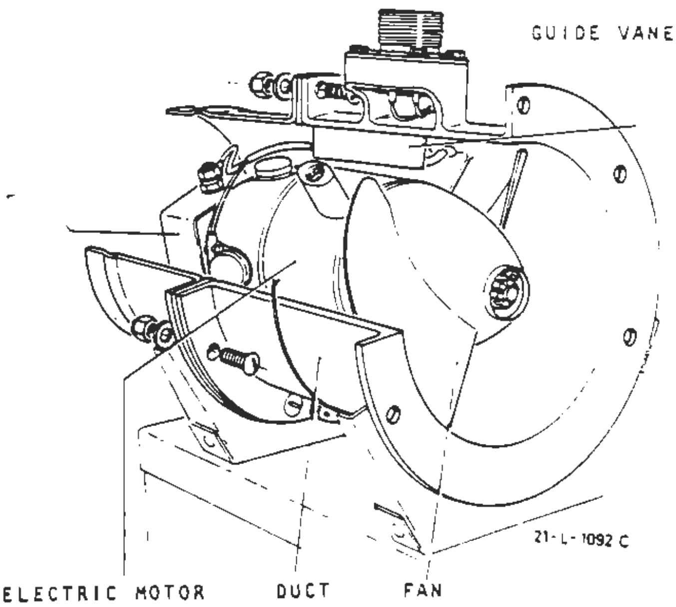
SPILL VALVE



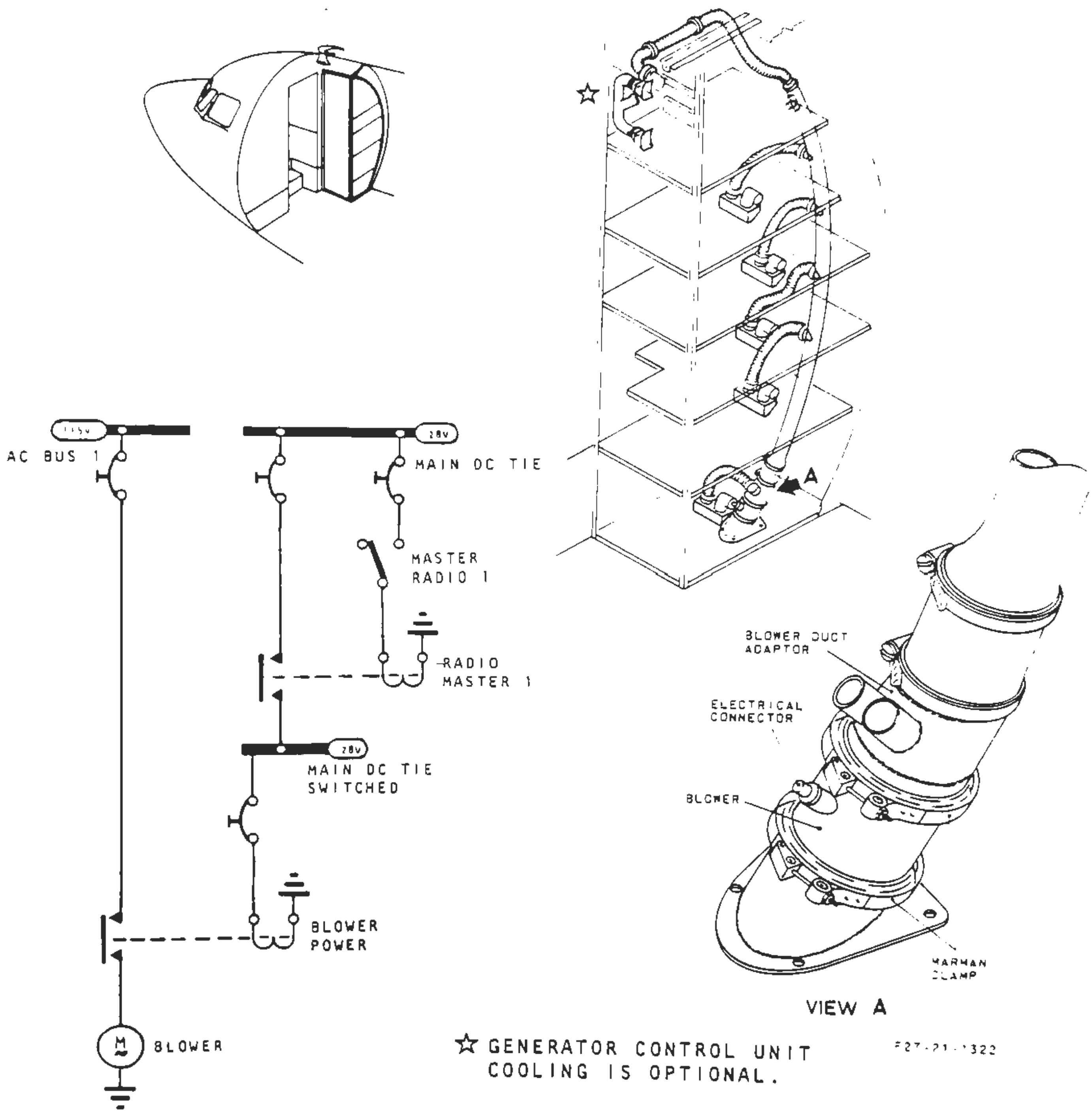
AIR CONDITIONING GROUND CONNECTION







GROUND BLOWER



☆ GENERATOR CONTROL UNIT
COOLING IS OPTIONAL.

F27-21-1322

RADIO RACK COOLING

20.0 AIR DISTRIBUTION

Conditioned air from the air conditioning compartment is ducted to the cabin via a port and non-return valve at the bottom RH side of the rear pressure bulkhead. This cabin-air supply duct extends forwards under the floor for approximately four meters.
The duct then divides into a left and right duct and is routed upwards to join onto LH and RH overhead air ducts, which feature a continuous outlet for cabin ventilation and outlet connections to the louvres located on the passenger service panels. The front of the RH overhead air duct extends further forwards to the cockpit.
Under the cockpit floor the duct is divided to supply air to the various outlets in the cockpit.

Where applicable, flexible hoses are connected to the air ducts to supply ventilation air to louvres in pantry areas, toilet compartment etc.
In addition to heating and ventilation purposes, the air is also used for demisting of cabin and cockpit windows.

The air leaves the cabin through grills in the wall near the floor and then flows rearwards under the floor to the outflow valves in the rear pressure bulkhead. After passing the outflow valves the air escapes to atmosphere via an opening in the fuselage tail cone.

20.1 Cabin Air Outlets

Each overhead air duct is covered by a row of flush-mounted passenger service, loudspeaker and blind panels. Air enters the cabin through a slot between the panels and the luggage bins. Louvres in the passenger service panels allow an individual airflow direction and quantity regulation.

All cabin windows, including the emergency exit windows, are demisted by air tapped from the overhead air duct via flexible tubes. The air enters the space between the inner and outer window panel at the top and escapes through a hole at the bottom of the window frame, however, the emergency exit windows are demisted from bottom to top.

20.2 Cockpit Air Outlets

Twin ducts to the cockpit run horizontally from the cabin RH overhead air duct through the cockpit rear wall and then downwards behind the co-pilot's seat to the space under the cockpit floor. Under the floor the air is ducted through an electric heater and via a manifold to two floor outlets, two sidewall outlets and the windshield outlet assembly. The small duct to each separate outlet is provided with a butterfly-type flow control valve. These valves can be controlled by ratchet-type levers located below and above the cockpit side panels. The floor and windshield outlet valves are springloaded and operated by bowden cables; the side wall outlet valves are operated by control rods.
A separate adjustable louvre is fitted to the air duct behind the co-pilot's seat. The windshield outlet assembly consists of two outlets, one for each each windshield panel.
Flexible tubes, tapped from the windshield outlets supply an air stream between the panels of the direct vision windows for demisting purposes.

Additional louvres are located in front of the cockpit side panels near the main instrument panel and are connected by means of flexible hoses to the air duct just upstream of the electrical heater.

NOTE: Maritime aircraft have additional cockpit ceiling ventilation. Air for this ventilation is derived from the LH overhead air duct.

20.3 Cockpit Heater

The heater consists of a section of light alloy ducting in which three elements are fitted, each element contains two coils. The elements are connected to a terminal strip mounted on the duct and protected by a cover. Three thermoswitches for overheat protection are installed in the duct, one downstream of each element. These thermoswitches are set to open the circuit when the temperature exceeds 100 degrees C. Screens are fitted in the heater duct entry and outlet to prevent entry of foreign objects during maintenance.

With the COCKPIT HEATER switch, located at the RH side panel, in the HALF position the left-hand heater relay is energized allowing AC power to be supplied to only three coils in the heater. With the switch in FULL position, both heater relays are energized causing all six coils to be supplied. When overheating conditions arise the thermoswitches will de-energize one or both heater relays, depending on the place inside the heater where the overheat condition exists.

20.4 Ducting and Insulation

The ducting consists mainly of large diameter thin wall duct sections manufactured from fibreglass reinforced plastic. However, flexible tubing is used within some parts of the pressurized cabin. To minimize heat losses during air transit, the duct, tubing and most of the components are surrounded by insulating blankets. These blankets consist of fibreglass pads enveloped in neoprene coated fibreglass covers which are laced to the ducts. Several types of connections are used between the duct sections and components.

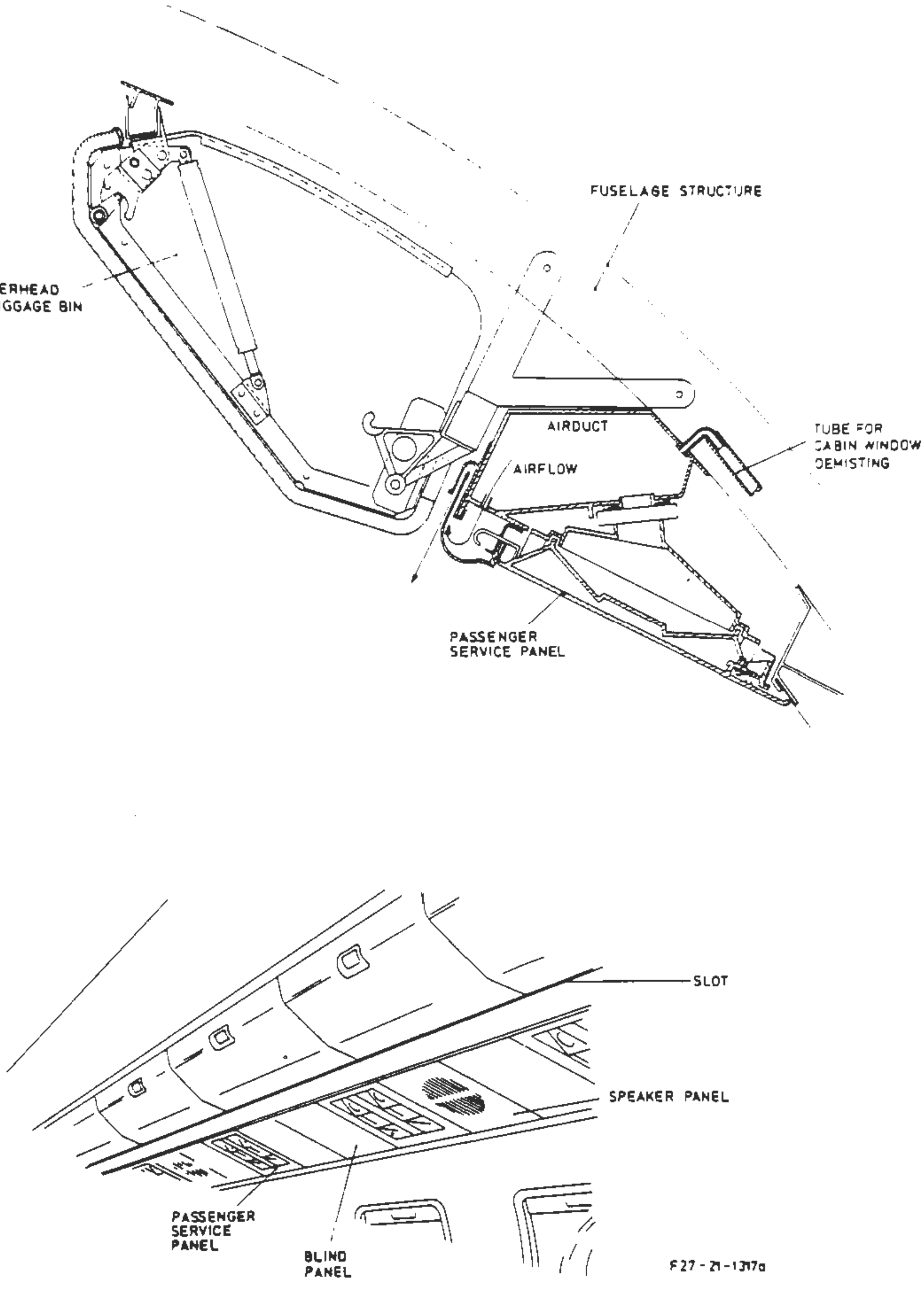
Type A: A silicone rubber sleeve is fitted over the duct ends and is secured with jubilee clamps. To prevent damage to the sleeve a special back-up ring is installed under the clamps. This type of connection is used outside the pressurized compartment and serves also as an expansion joint. The sleeve connection is supported by a bracket or strengthened by a joint strip.

Type B: A Marman clamp connects two specially shaped flanges. In this connection a silicone rubber O-ring is interposed for sealing. This type of connection is used mainly between duct sections and components, outside the pressurized compartment.

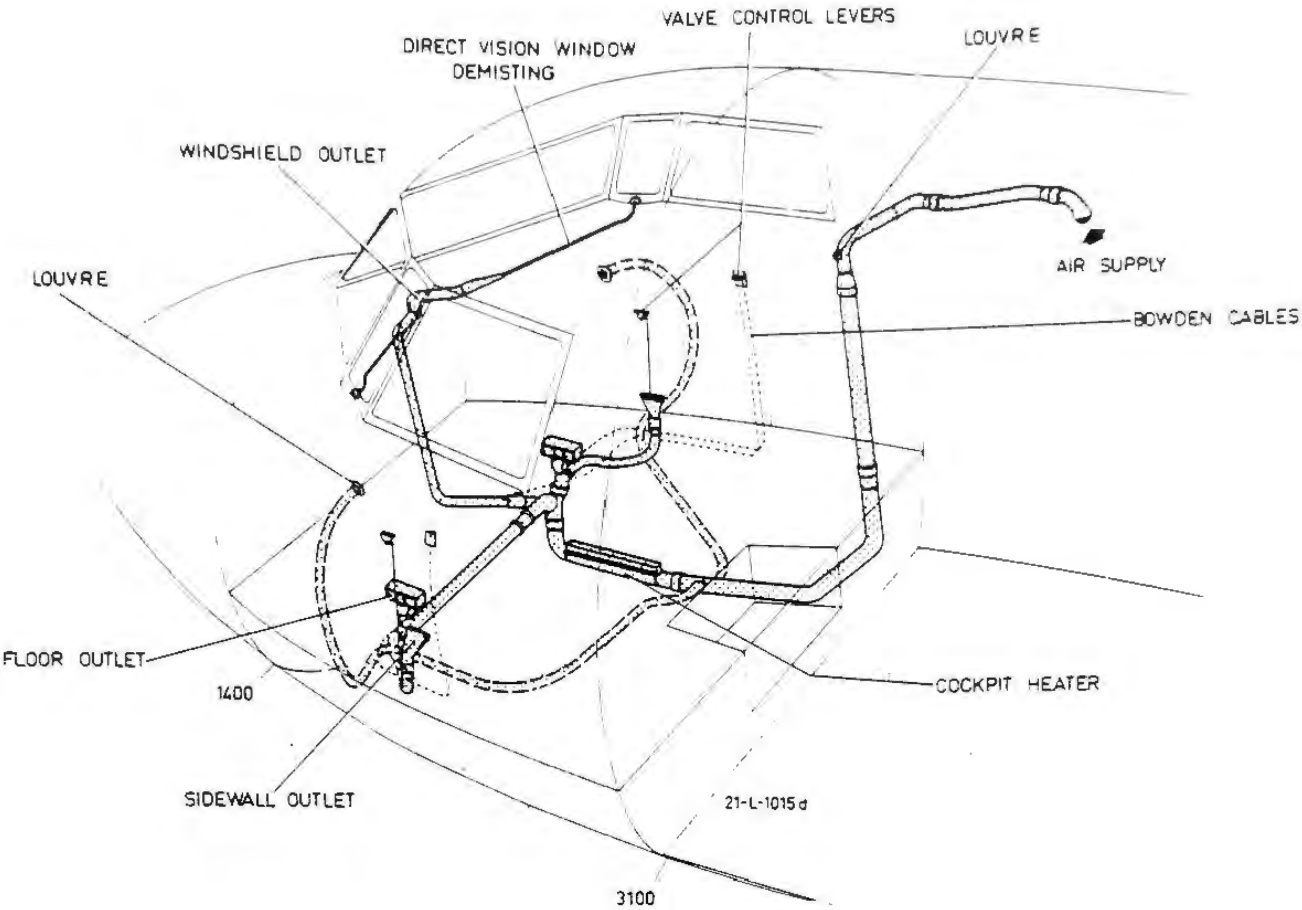
Type C: Flange joint, with a gasket interposed. These are mainly used for heat exchanger ducting connections.

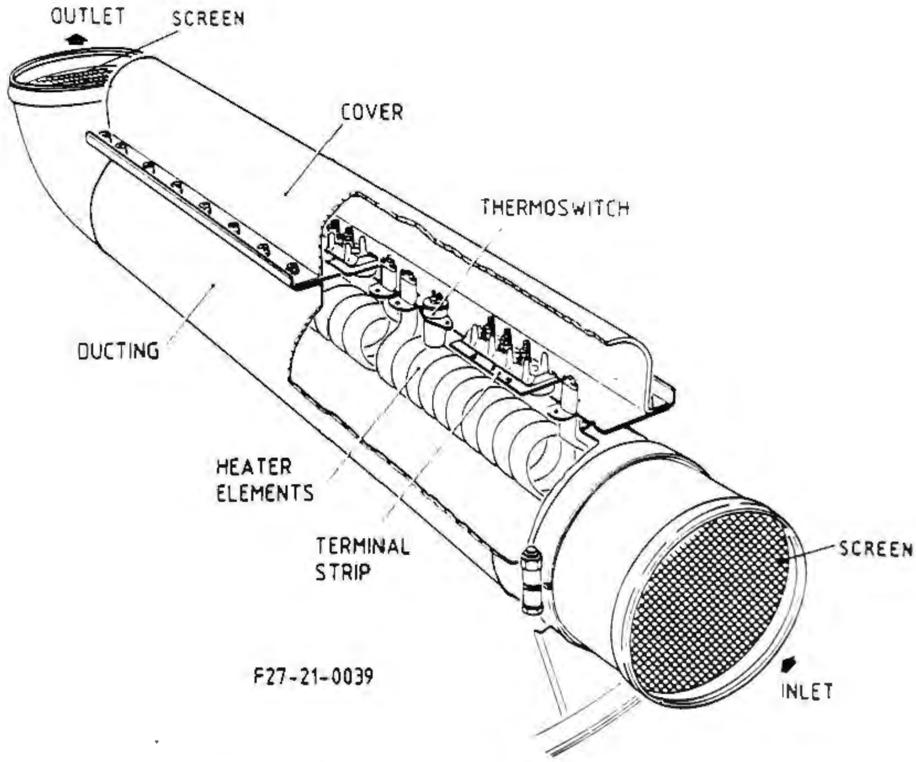
Type D: In these connections two flanges, one male and one female, are bolted together with a rubber seal fitted in between. These type connections are used within the pressurized compartment.

END

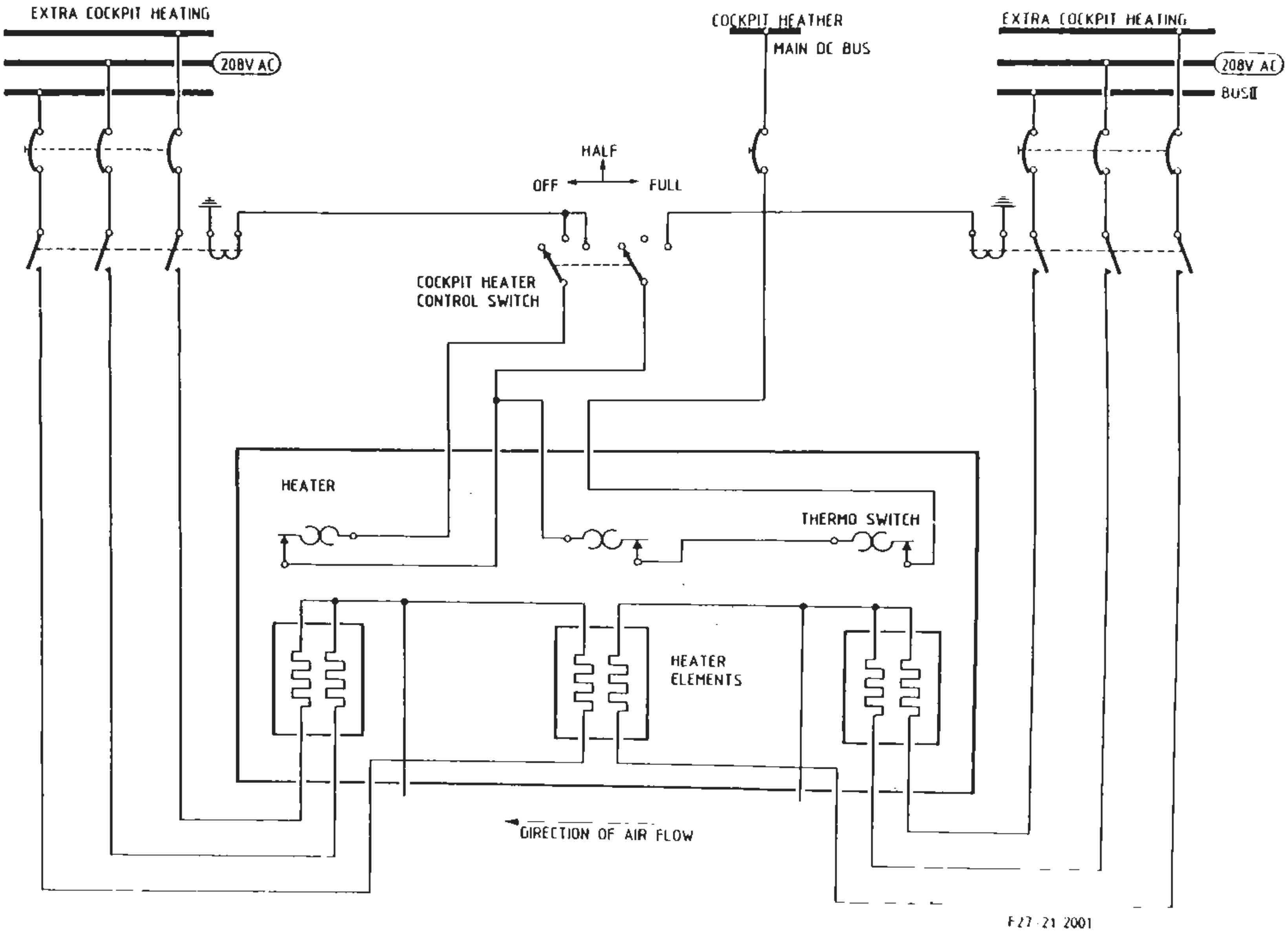


CABIN VENTILATION AIR OUTLETS

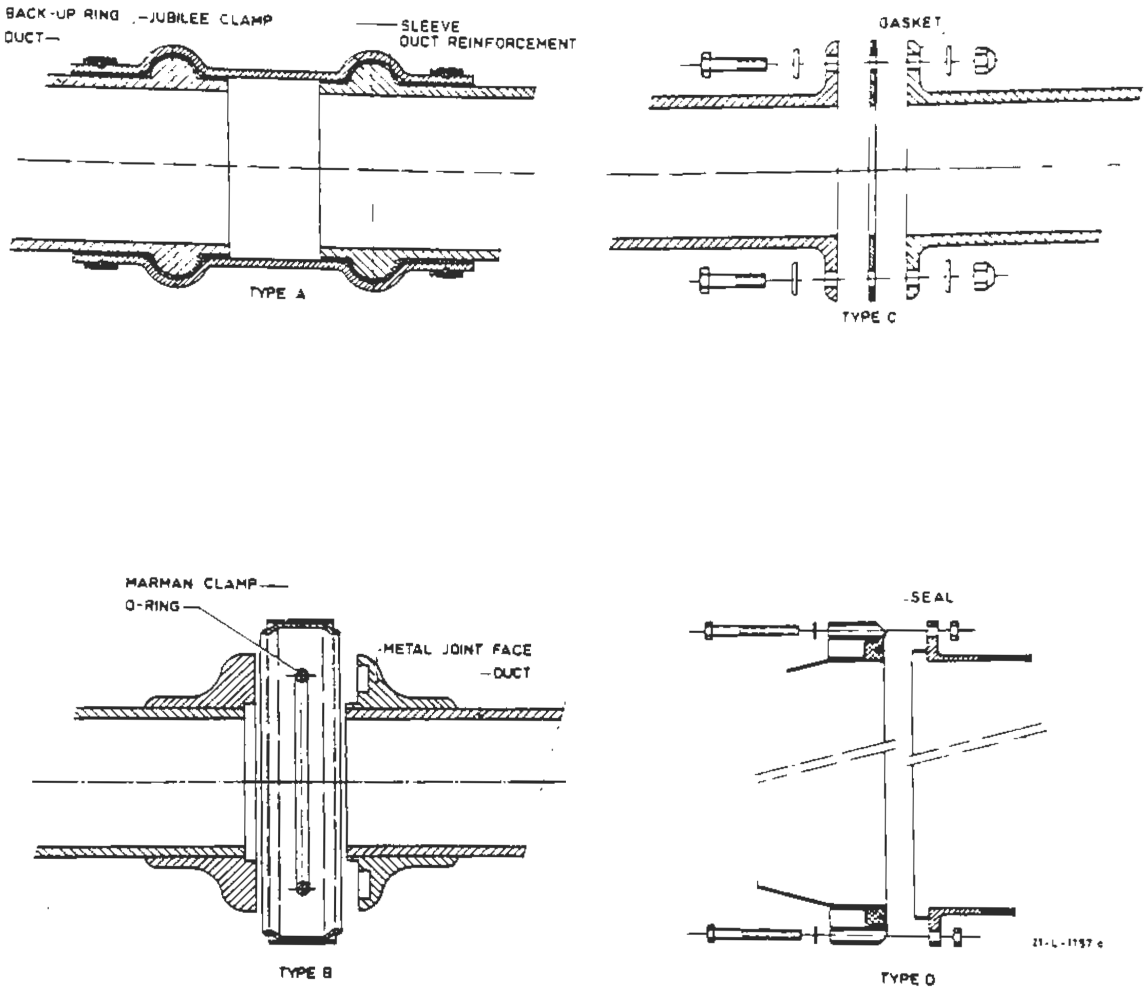




COCKPIT AIR DISTRIBUTION



COCKPIT HEATER



TYPICAL DUCT CONNECTIONS

40.0 TEMPERATURE CONTROL

Description

The temperature control system can be divided in a heating system and a cooling system.
The principle used for heating is that compression of air generates heat. A pressure rise across the blowers causes the air temperature to increase which is sufficient to heat the cabin and cockpit in standard atmospheric conditions.
However, if for any reason this temperature increase is not sufficient to heat the cabin, additional compression heating can be obtained by partially closing a choke valve in the common supply duct.
Because the cockpit is at the extreme end of the supply ducting an extra electrically-operated cockpit heater is installed in the cockpit air supply duct in order to provide an additional temperature increase.

When the choke valve is full open (no additional compression heating) and the temperature of the air is too high, cooling of the air is necessary.
Downstream of the choke valve in the common supply line an air-to-air (primary) heat exchanger is installed, cooling the air when there is a ram air flow through the heat exchanger.
Because ambient air is used as a cooling medium, cooling of the ventilation air below ambient temperature is not possible by means of the primary heat exchanger only. A super cooling system, connected downstream of the primary heat exchanger, consists of a cooling turbine/ compressor assembly, a secondary heat exchanger and a water separator to remove excessive moisture.
The cooling turbine cools the air by expansion. To prevent the turbine of overspeeding, the turbine drives a compressor which limits the turbine rpm by compressing the air from the primary heat exchanger.
The temperature increase, thus obtained, is removed in the secondary heat exchanger.
After passing the cooling unit the ventilation air temperature is below ambient. When a higher temperature is required, a by-pass valve opens a way for by-passing the cooling unit. Relatively warm air from the blowers and cooled air from the cooling unit are then mixed. So the mixed air temperature depends on the position of the by-pass valve. The choke valve and the by-pass valve can be stopped in intermediate positions to provide a wide range of temperature selections.

In the extreme heating and cooling conditions the valves are in the positions as shown in the following table.

CONDITION	CHOKE VALVE POSITION	BY-PASS VALVE POSITION
Max. heating	Almost closed	Open
Max. cooling	Open	Closed

To limit the differential pressure across the blower a pressure switch is connected to the common supply duct.
When the duct pressure exceeds 8.5 psi the choke or by-pass valve will stop further closing.
In case the duct pressure exceeds 9.5 psi the choke or by-pass valve will open to reduce the duct pressure.
When the pressure switch fails a duct relief valve relieves excessive air pressure.

Choke and by-pass valve positions are controlled by the temperature control system which can automatically or manually be operated.
The automatic temperature control system comprises a temperature control switch, a temperature selector knob, a temperature control unit and two temperature sensors.

For manual temperature control the temperature control switch only is used.
The temperature control switch and selector knob are located on both the stewardess panel and cockpit overhead panel.
With the AURHORITY switch on the overhead panel the temperature can be selected either from the cockpit or the cabin.

NOTE: The AUTHORITY switch and stewardess panel are not applicable in F27 troopship or maritime.

On the overhead panel a dual temperature indicator reads the cabin and duct temperatures. A dual position indicator is used to indicate choke and by-pass valve positions.

Operation

A. Automatic temperature control

Automatic temperature control is effective when the temperature control switch is in AUTO. The required cabin temperature can be selected with the temperature selector knob. When the cabin temperature equals the selected temperature a circuit within the temperature control unit is balanced and the valve actuating system has been adjusted accordingly.
However, deviations from the pre-selected condition are translated by the temperature control unit into "hot" or "cold" signals to re-position the valves in order to restore once again a balanced circuit condition.

1. Operation to reduce cabin temperature

When the cabin temperature is higher than selected, the temperature control unit produces a "cold" signal. This signal first activates the choke valve to open it and then this signal is applied to the by-pass valve to close this valve. A limit switch inside the by-pass valve closes after approximately 20 degrees movement and energizes a change-over relay which contacts will bring the 8.5 psi pressure switch in the circuit.
This low pressure switch causes the by-pass valve to stop, when

the pressure in the common supply duct increases to 8.5 psi. If the duct pressure, for any reason, exceeds 9.5 psi the high pressure switch causes the by-pass valve to open.

2. Operation to increase cabin tempqrature

When the cabin temperature is lower than selected, the temperature control unit produces a "hot" signal. This signal first activates the by-pass valve to open it while 3 degrees before the full open position the change-over relay de-energizes. When the by-pass valve has reached the full open position the "hot" signal is transferred to the choke valve to close this valve. The low pressure switch stops choke valve movement at 8.5 psi duct pressure while at 9.5 psi the high pressure switch causes the choke valve to open.

The total time for a complete cycle from maximum heating to maximum cooling is approximately 40 seconds. However, normally no complete cycles will be made: some movement to more or less heating or, more or less cooling will be sufficient to obtain the desired cabin temperature.
When the actuating signal stops the valves remain in the position of that moment.

B. Manual temperature control

When the automatic temperature control fails, manual temperature control can be effected by moving the temperature control switch either to the HOT or COLD position for approximately 4 seconds. Cabin temperature should always be allowed to stabilize before making new selections. From the HOT or COLD positions, the switch is springloaded to the centre-off position.

C. Ground operation

During operation the by-pass valve automatically opens to prevent effective cooling turbine operation. This is arranged by the action of a ground safety relay and the RH shock strut switch.
To prevent the valves to a full heating position prior to engine starting the ground safety relay interrupts the automatic heating signals from the temperature control unit.

40.1 Temperature sensing and command system

The temperature sensing and command system regulates the pre-temperature over a 15 degrees C - 26 degrees C range. The system consists of the temperature selector knob, a cabin temperature sensor, a temperature anticipator and the temperature control unit. If the cabin temperature deviates from the selected value, signals from the temperature anticipator and balance circuit, formed by the temperature control unit and converted into electrical converted signals to operate choke and/or by-pass valve.

40.2 Temperature Control Unit

The temperature control unit, located in the radio rack provides 28 V DC output voltages to the choke and/or by-pass valves in order to obtain a cabin temperature equal to the selected temperature.

40.3 Cabin Temperature Sensor

The cabin temperature sensor is fitted in a venturi, located behind a "dummy" loudspeaker panel near the RH emergency exit window. The sensor is a thermoresistor and any change in cabin temperature causes an unbalance and a signal is produced by the temperature control unit to re-position choke and by-pass valve.

40.4 Temperature Anticipator

A thermo-resistor unit also forming part of the balance circuit, is located in the cabin air supply duct below the flooring in front of the rear pressure bulkhead. The anticipator contains two thermo-resistors, one of them being exposed directly to the airstream to provide a quick response, and the second one being insulated, to provide a slow response. The insulated resistor forms a "lag" section to anticipate the temperature conditions which, in conjunction with the cabin thermo-resistor, and proportional valve control, eliminate any hunting of the control system. Another feature of this unit is temperature limiting to prevent excessive duct temperatures. This is established by comparing the resistance values of the insulated resistor and the exposed resistor.

40.5 Choke Valve

The choke valve is an electrically-operated butterfly-type valve located in the air conditioning compartment.
The valve is connected to the common supply ducts by means of silicone rubber sleeves and clips. A heat shield protects the electric motor against heat radiated by the valve housing.

The butterfly valve is made up of a sealring secured firmly between two plates, while the shaft of the valve is supported by ball bearings. The electric actuator, mounted externally to the valve housing consists of a DC motor and a reduction gearbox. Limit switches are incorporated in the gearbox to stop the motor when the valve reaches its maximum travel. A lever coupled to the valve shaft drives an arm of the position transmitter which provides a signal for the valve position indicator in the cockpit.

40.6 By-pass Valve

The by-pass valve is similar to the choke valve except for an auxiliary microswitch which is fitted in the actuator in addition to the open and close limit switches. This switch is depressed as soon as the valve is 20 degrees closed and is released again as the valve returns to 3 degrees from the full open position. The valve is located in the air

conditioning compartment.

40.7 Choke Valve and By-Pass Valve Position Indicating System

The position of choke valve and by-pass valve is indicated by a dual position indicator on the cockpit overhead panel. Linkages fitted to the shafts of both valves operate the transmitters which provide electrical signals for the indicators. The system operates on the desynn principle.

The transmitters consist of a toroidal resistor with three tapping points spaced 120 degrees apart. The tappings are connected to the terminals for the indicator connections. Two contact brushes, spaced 180 degrees apart, will rotate in the resistor when the lever on the transmitter is driven. This will cause the currents to the tappings to vary.

The indicator comprises a permanent magnet rotor pivoted to rotate within soft iron stators, the pointers of the indicators being directly attached to the rotor spindles. The stators carry a star connected winding and this is connected, via three wires to the terminals on the transmitters.

40.8 **Heat Exchangers**

The primary and secondary heat exchangers are of aluminium construction and consist of a number of tubes anchored between two header plates. Ventilation air flows through the tubes whilst cooling air passes over the tubes. Each heat exchanger is bolted to an assembly of supporting beams in the air conditioning compartment. Cabin ventilation air and cooling air is supplied to each heat exchanger through fibreglass plastic duct sections.
The cooling air is collected by a fibreglass plastic airscoop and escapes through a flush grilled outlet on the other side of the air conditioning compartment. In order to improve the heat transfer characteristics of the exchanger, the heat tubes are flattened and dimpled.

The primary heat exchanger is of the single-pass configuration i.e. the cooling air passes only once over the tubes, while the tubes of the secondary heat exchanger are arranged in a two-pass configuration. This configuration refers to the fact that the ventilation air passes twice through the exchanger, the cooling air flow being supplied in the same way as in the case of the primary heat exchanger.

40.9 **Cooling Turbine**

The cooling turbine consists of a centrifugal compressor and a radial expansion turbine fitted on a common shaft and enclosed by a central housing and two scroll assemblies. The shaft is supported by means of two ball bearings fitted in a carrier which is spline-mounted into the central housing to allow for temperature expansion. The carrier also supports felt wicks which distribute oil over the central part of the shaft.
This oil is dispersed by the rotation of the shaft and the resulting oil

mist is sucked through the bearings by means of slinger rings mounted outboard of each bearing. An extension of the slinger ring forms a seal to prevent compressed air from leaking into the central housing.
The central housing is used as an oil sump and is therefore provided with a bayonet-type filler cap with dipstick. The sump contains 525 cc of oil.
A breather opening at the top and a drain opening at the bottom are connected to fittings in the fuselage bottom skin by means of flexible hoses. The drain opening is plugged and wirelocked. The complete unit is fitted on four shockproof mountings in the air conditioning compartment just in front of the access panel.

40.10 Water Separator

The water separator consists of a condenser assembly and a water collector ring inside, an inlet and outlet shell. The condenser assmbly comprises a conical condenser support with a large number of openings, a fibreglass cloth condenser and a safety by-pass valve. The fibreglass cloth condenser covers the exterior of the support.
Cold humid air entering via the inlet shell passes through the condenser and the condenser support to the outlet side of the unit. Small moisture particles in the air combine and increase in size in the fibreglass condenser.
Due to the special shape of the openings in the condenser support, the air gets a swirling movement which causes the droplets to be thrown against the surface of the collector ring in the outlet shell. The accumulated moisture runs down and is drained overboard through a filter, a restrictor and a flexible hose to an opening in the fuselage bottom skin.
To prevent obstruction of the air supply when the condenser is dirty or frozen, a safety by-pass valve is fitted which opens when the pressure differential across the condenser exceeds 2 psi.
The water separator is strapped to felt-covered brackets on the adjacent structure in the air conditioning compartment.

40.11 Pressure Switch

The purpose of the pressure switch is to limit the differential pressure across the blower. It is located in the air conditioning compartment against the rear pressure bulkhead. In the housing of the unit a low and high pressure switch are fitted.
The low pressure switch is set at 8.5 psi and breaks the circuit to the close windings of the choke valve or by-pass valve, when the pressure in the common supply duct exceeds this setting due to closing of either of these two valves.
If the duct pressure should continue to rise, regardless the interrupted closing action of the appropriate valve, the high pressure switch will change over its contacts at 9.5 psi. Changing of the contacts provides a current supply to the open windings of the appropriate valve so as to run it open until the duct pressure has decreased to the setting of the switch.

40.12 Duct Relief Valve

The duct relief valve, installed in the air conditioning compartment, can vent excessive duct pressure at 9.8 psi when the pressure switch fails to operate. At a decreasing pressure the relief valve closes at a duct pressure of 8.8 psi.

An important feature of the valve is that it incorporates a compensating mechanism, which results in only a small increase in back pressure between initial opening of the valve and its fully open position. When the pressure in the duct rises above the setting of the valve, it opens to allow blower air to escape to atmosphere. As the valve head moves, the roller and lever assemblies rotate and the upper rollers, bearing against the flange of the spring seating, compress the valve spring.
Continued opening of the valve causes the lower rollers to continue their outward movement and, due to the shape of the roller levers, the upper rollers continue to move inwards.
This action moves the point of application of the forces concerned which compensate for the increasing compression of the spring with valve movement.
The pressure differential can thus be controlled to the required value, irrespective of the flow through the relief valve, provided that the maximum capacity of the valve is not exceeded.

40.13 Cabin and Duct Temperature Indicating System

The cabin and duct temperature are indicated on a dual temperature indicator, located on the cockpit overhead panel. The indicator receives its electrical signal from a cabin temperature bulb, located in the venturi for the cabin sensor near the RH emergency exit, and from a duct temperature bulb located in the cabin air supply duct under the cabin floor forward of the rear pressure bulkhead.

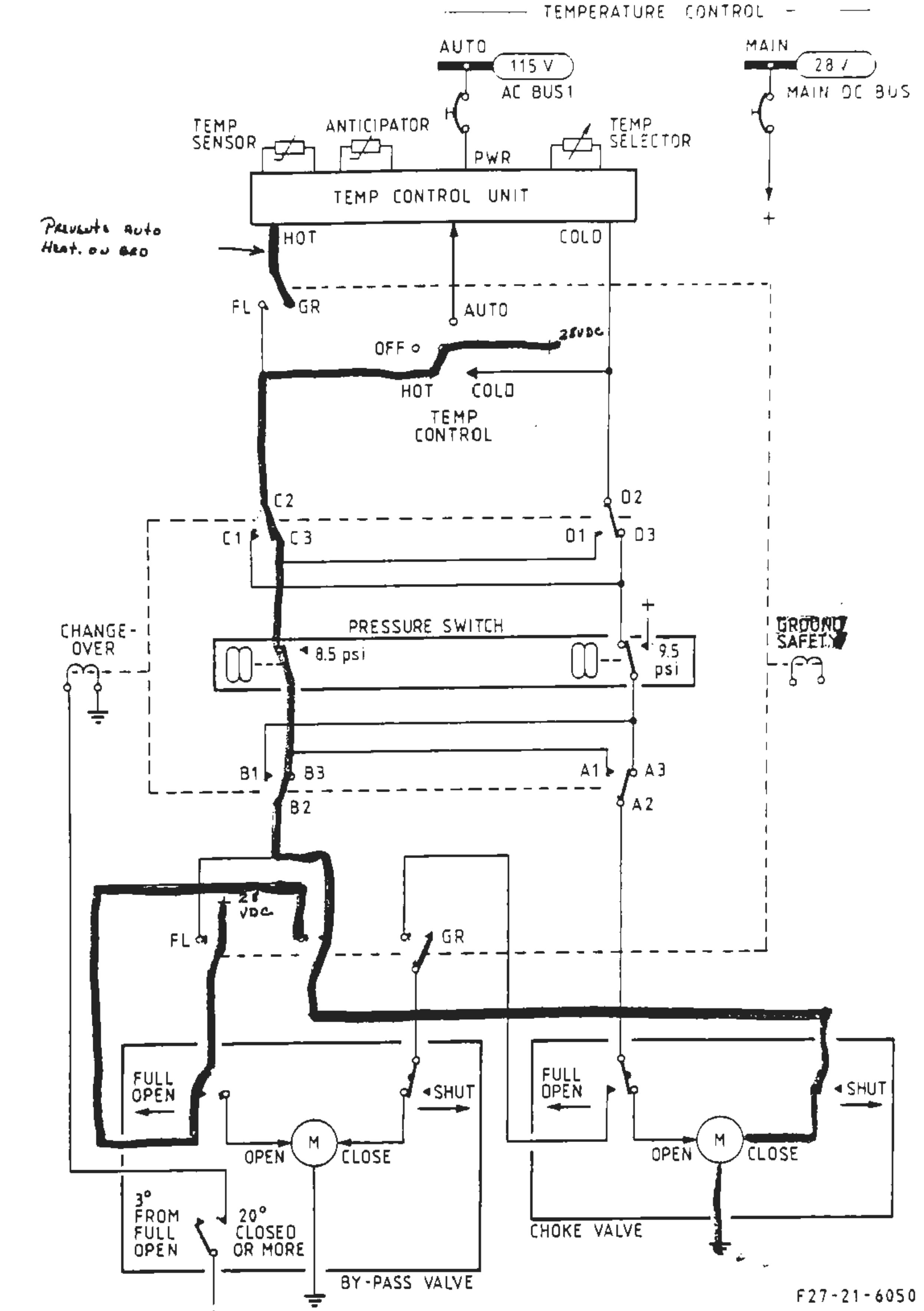
The temperature bulb consists of a temperature sensitive element of coiled platinum wire, helically wound on a small cylindrical former of anodized aluminium. The element is housed in the tip of a stainless steel rube which is welded at the element end and sealed with a metal/glass seal at the connection end.

The dual temperature indicator comprises two separate ratiometer movements in one casing. Each movement consists of two differently disposed moving coils pivoted in a permanent and unequal magnetic field. The position of the movement depends on the ratio of the currents through the coils. One current is constant, the other varies by the temperature voltage variations.
The left-hand scale represents the cabin temperature and is calibrated 30 - 110 degrees F. The right-hand scale represents the duct temperature and is calibrated 40 - 160 degrees F.

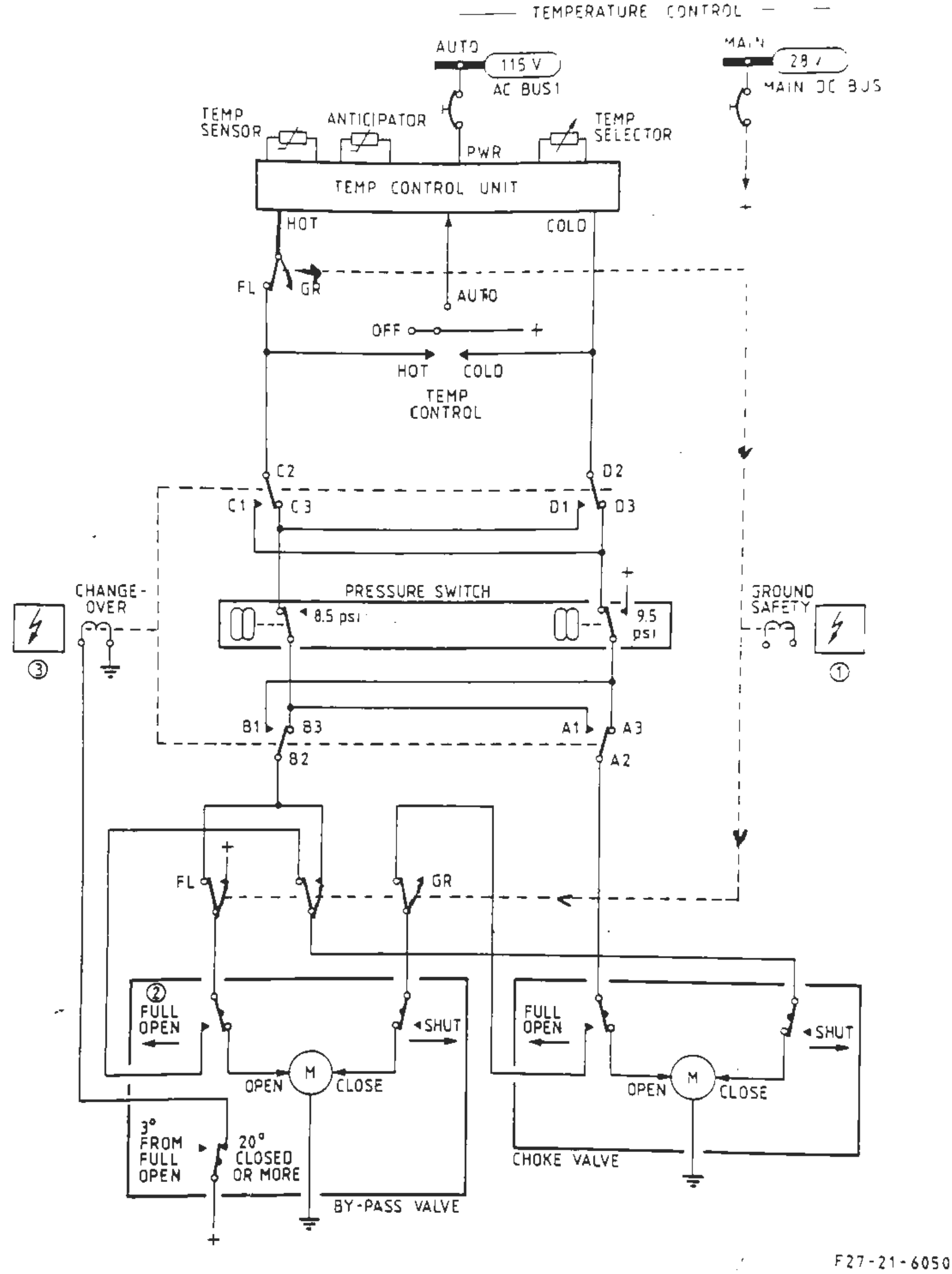
40.14 Cabin Venturi

The cabin temperature bulb and sensor are fitted in a venturi located behind a "dummy" loadspeaker panel near the RH emergency exit. The venturi is driven by air from the RH air conditioning duct and causes via the louvres of the "dummy" loudspeaker panel a flow of cabin air along the bulb and sensor.
NOTE: In a troopship the bulbs and sensor are directly exposed to cabin air.

END



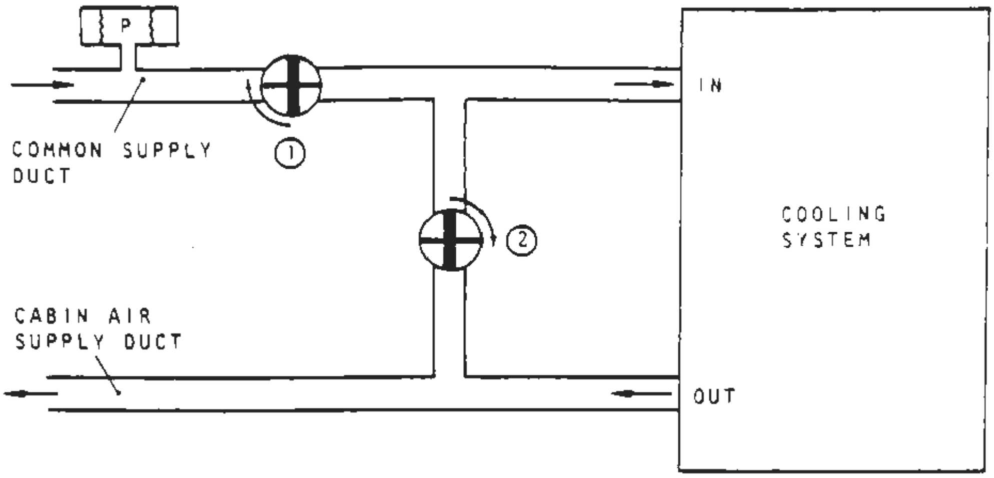
TEMPERATURE CONTROL CIRCUIT 1



TEMPERATURE CONTROL CIRCUIT 2

COLD DEMAND

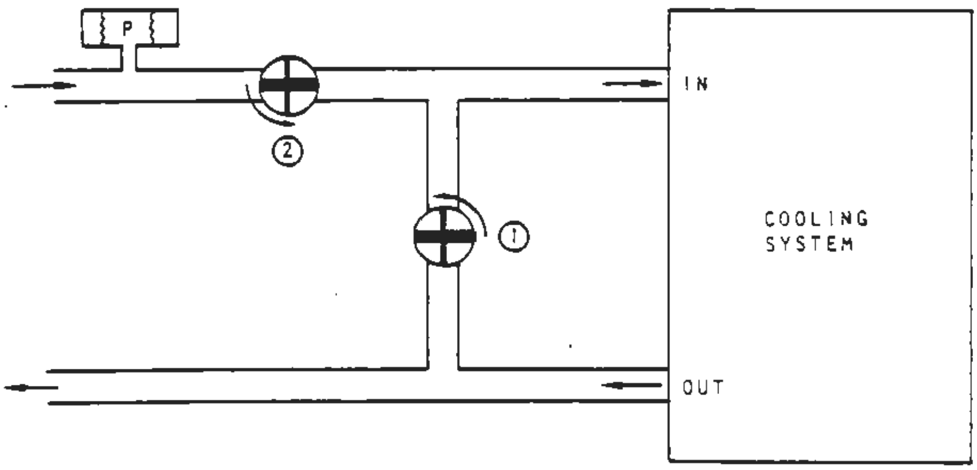
- CHOKE VALVE OPEN
- BY-PASS VALVE CLOSE



IF DUCT PRESSURE ABOVE 8.5 psi → STOP BY-PASS VALVE
IF DUCT PRESSURE ABOVE 9.5 psi → OPEN BY-PASS VALVE

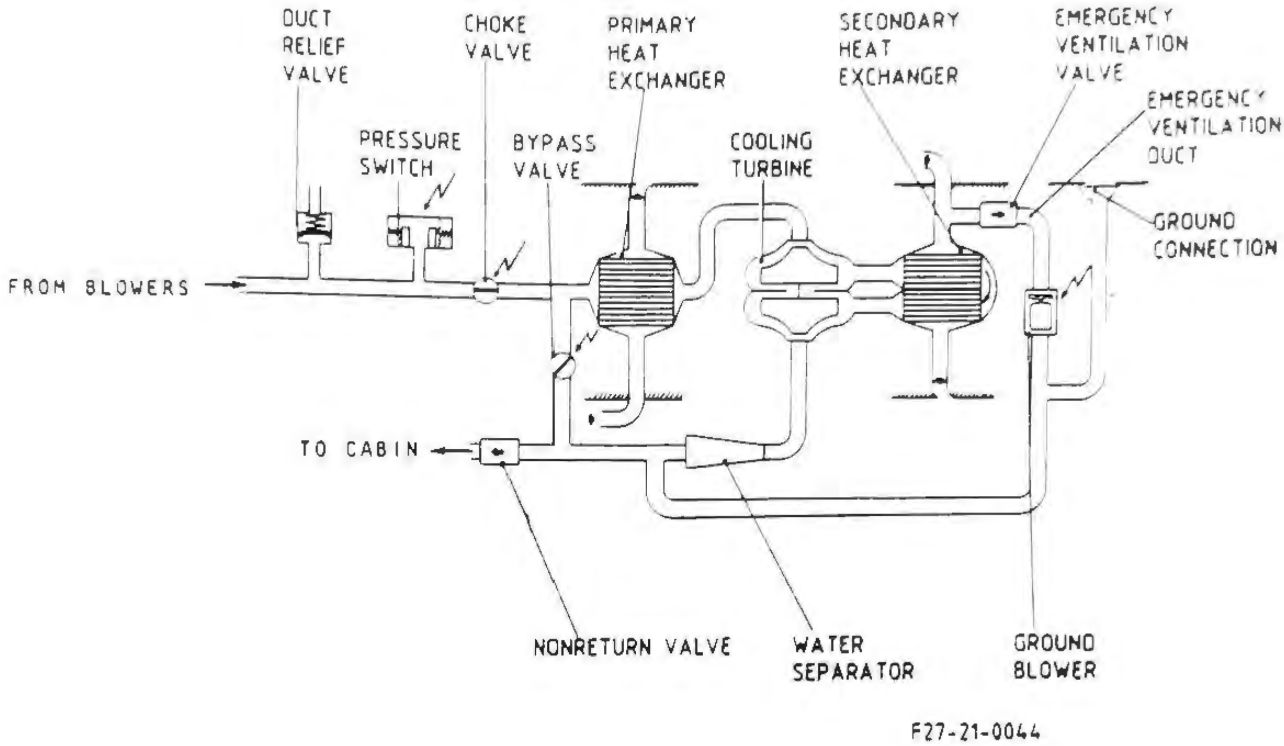
HOT DEMAND

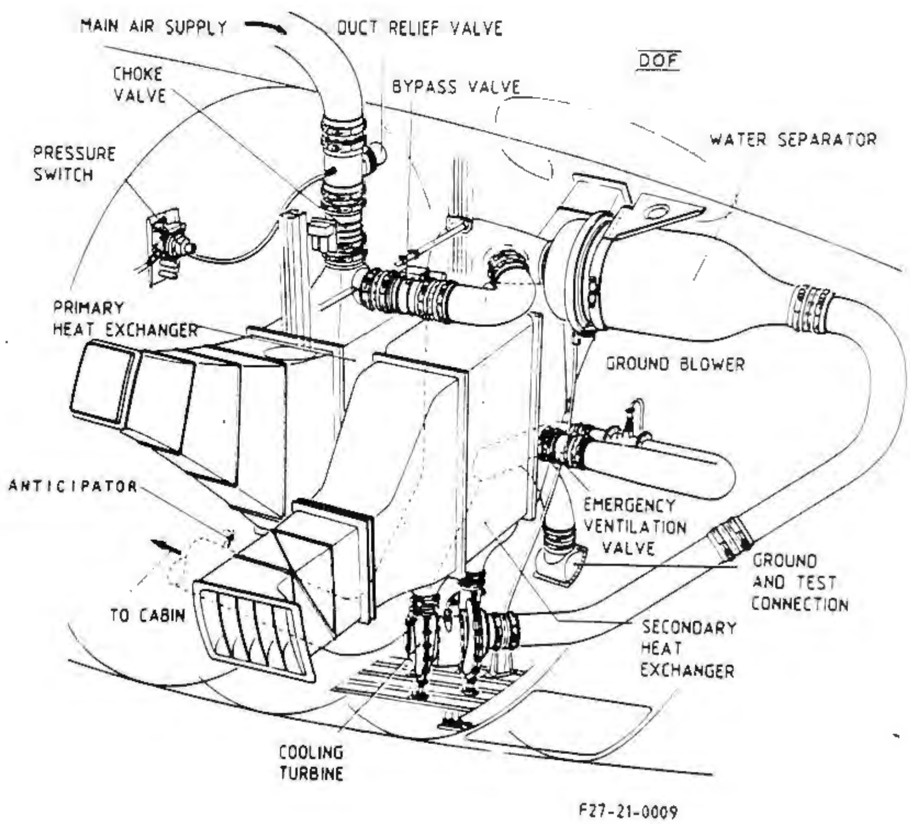
- BY-PASS VALVE OPEN
- CHOKE VALVE CLOSE



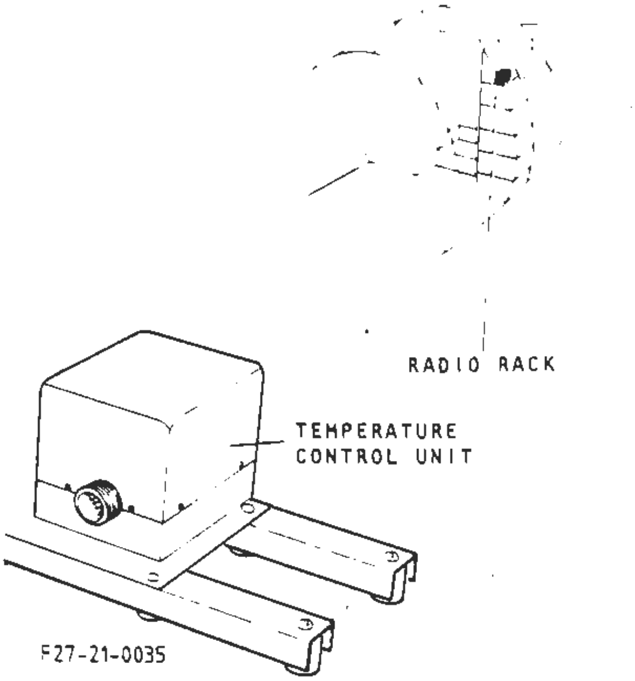
IF DUCT PRESSURE ABOVE 8.5 psi → STOP CHOKE VALVE
IF DUCT PRESSURE ABOVE 9.5 psi → OPEN CHOKE VALVE

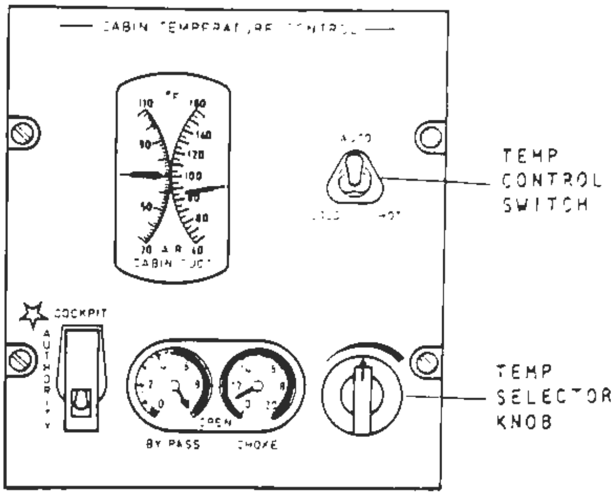
HOT OR COLD DEMAND



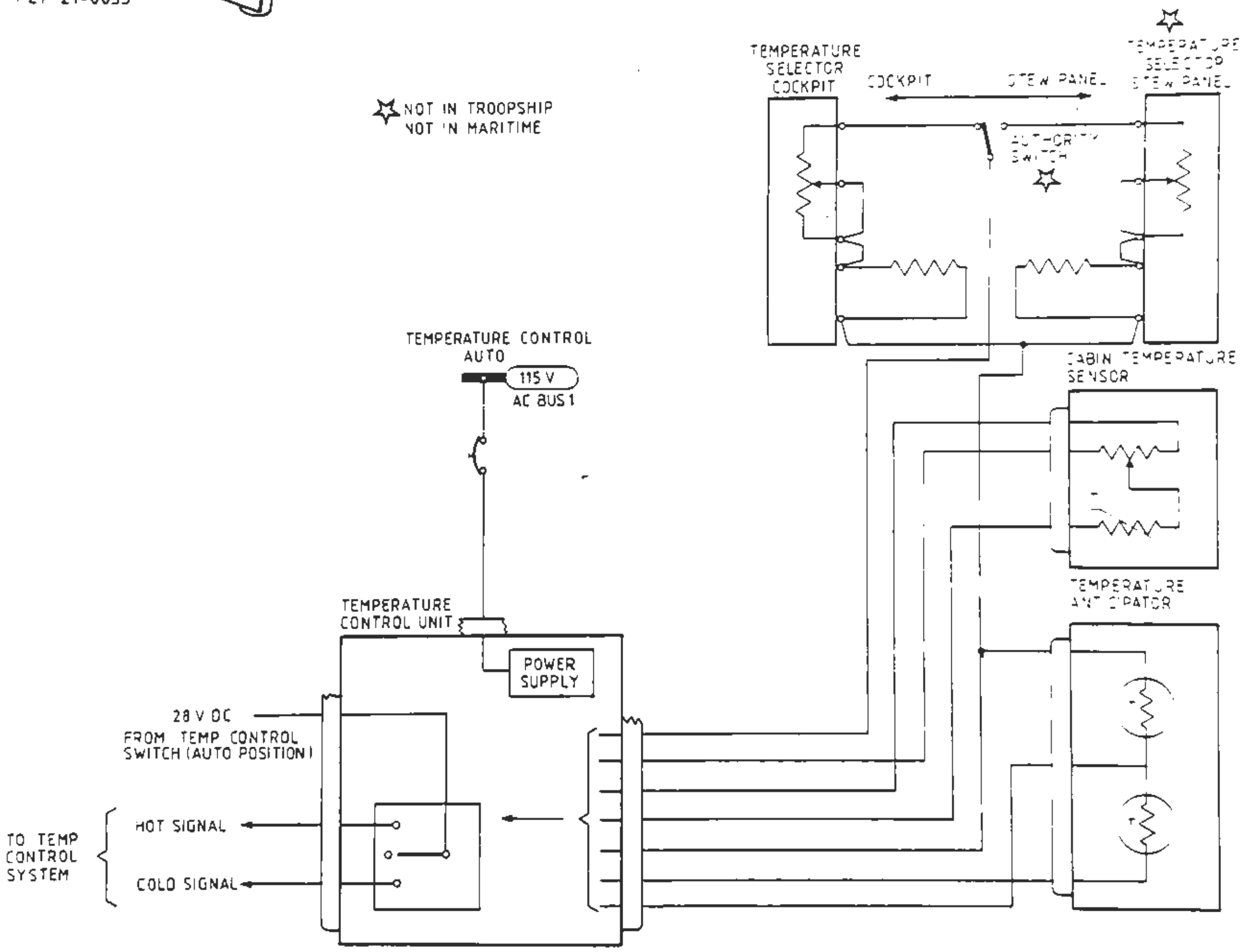


TEMPERATURE CONTROL SYSTEM



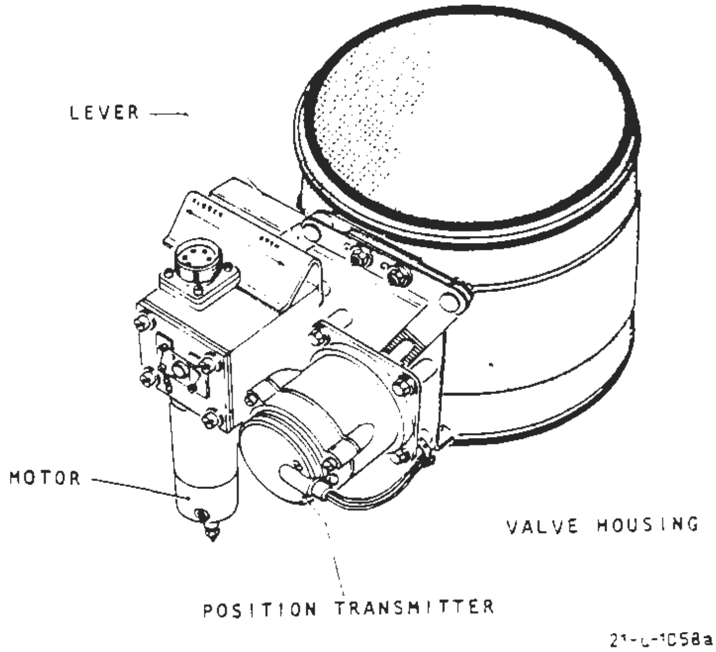


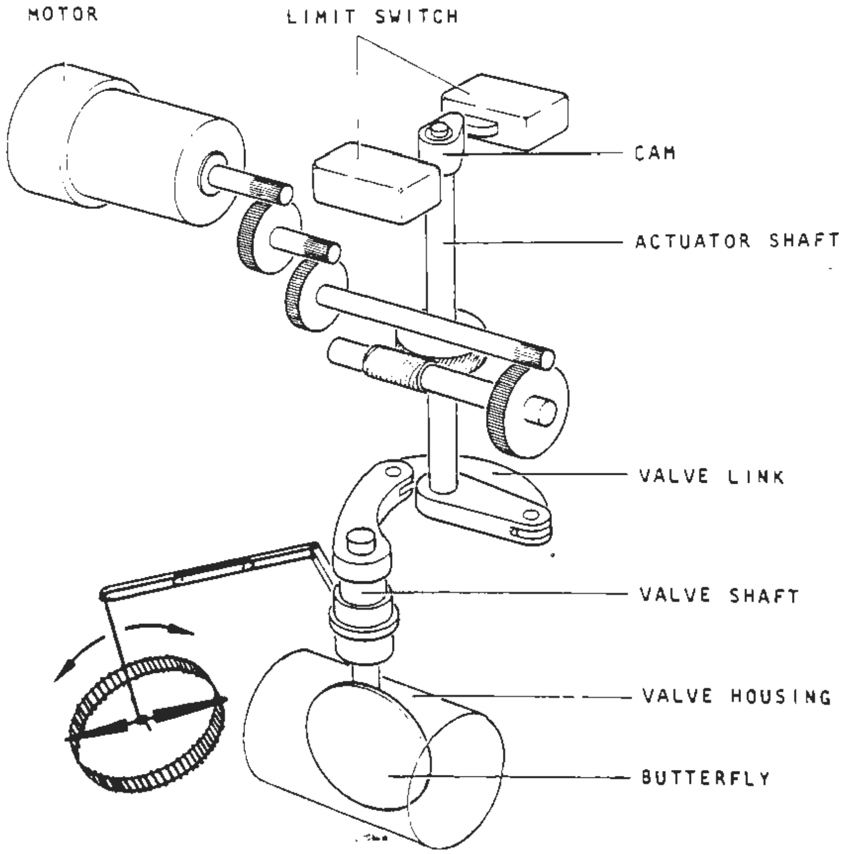
F27-21-0035



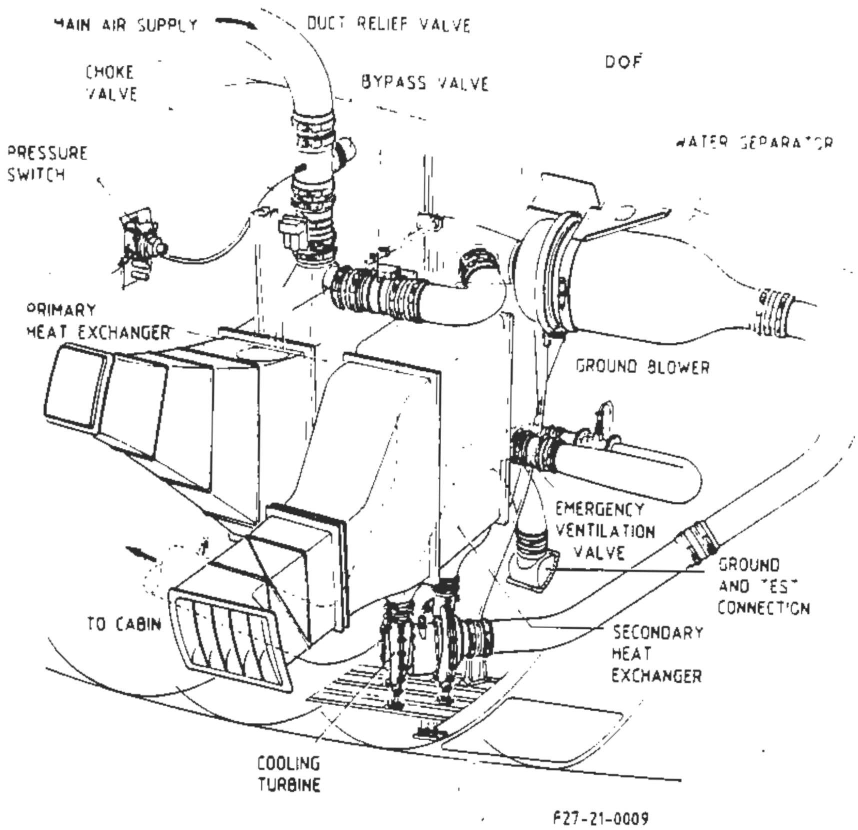
TEMPERATURE CONTROL UNIT

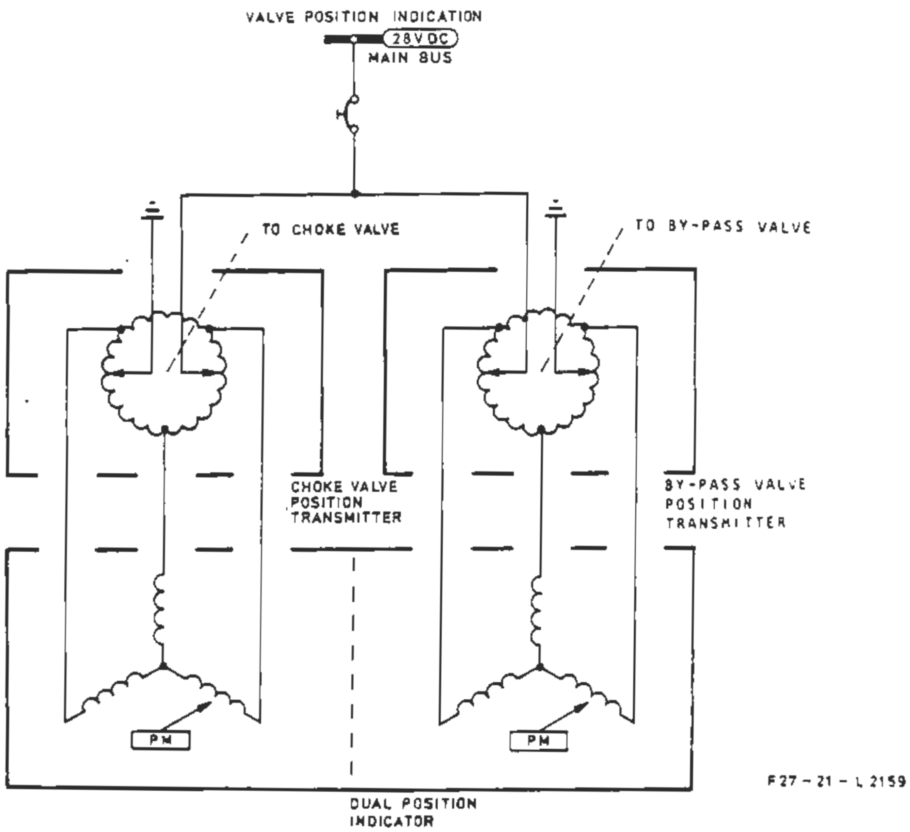
F27-21-6052


LEVER
MOTOR
VALVE HOUSING
POSITION TRANSMITTER
21-L-1058a

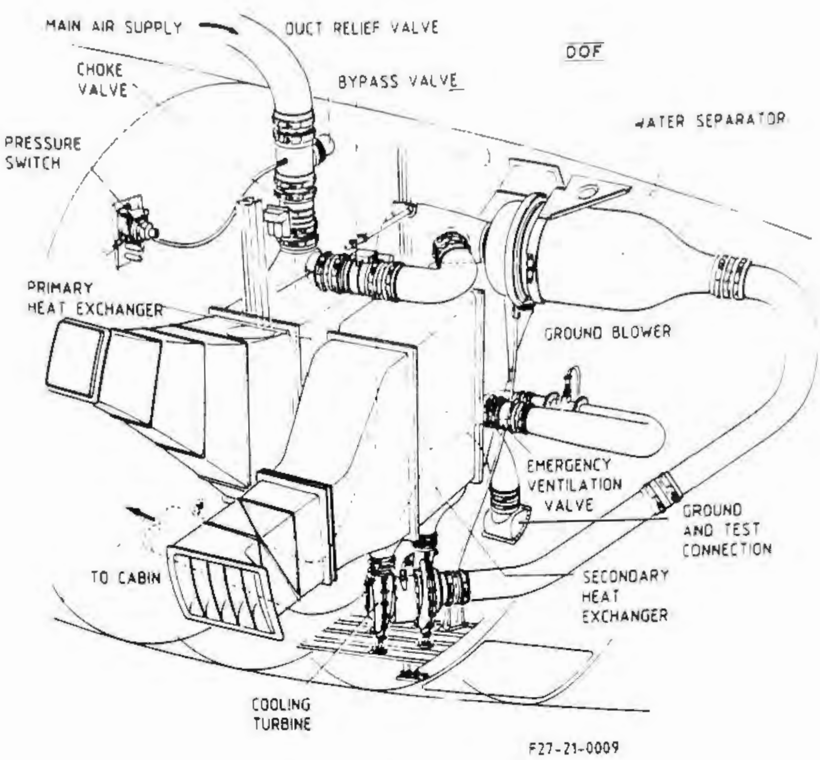

MOTOR
LIMIT SWITCH
CAM
ACTUATOR SHAFT
VALVE LINK
VALVE SHAFT
VALVE HOUSING
BUTTERFLY

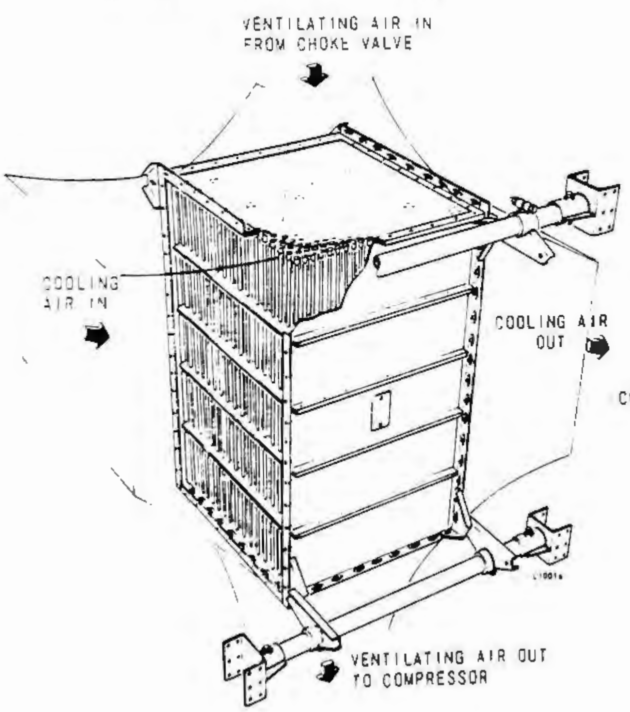
CHOKE VALVE

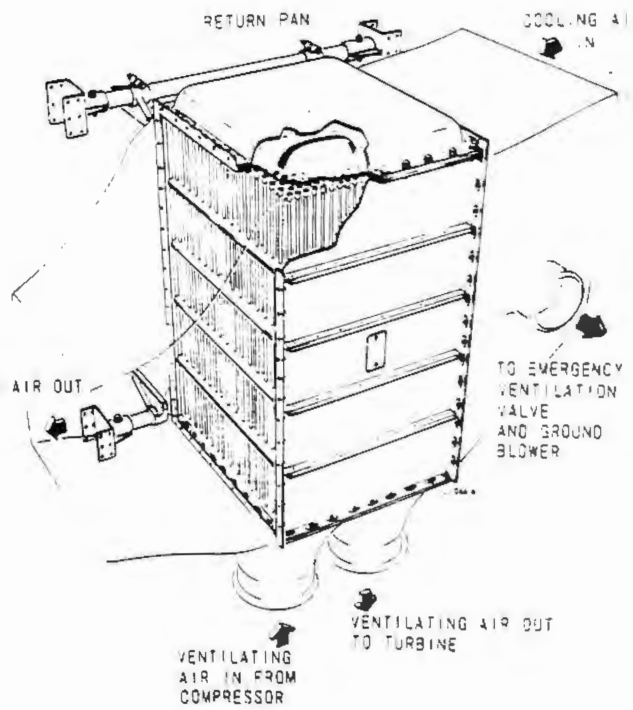




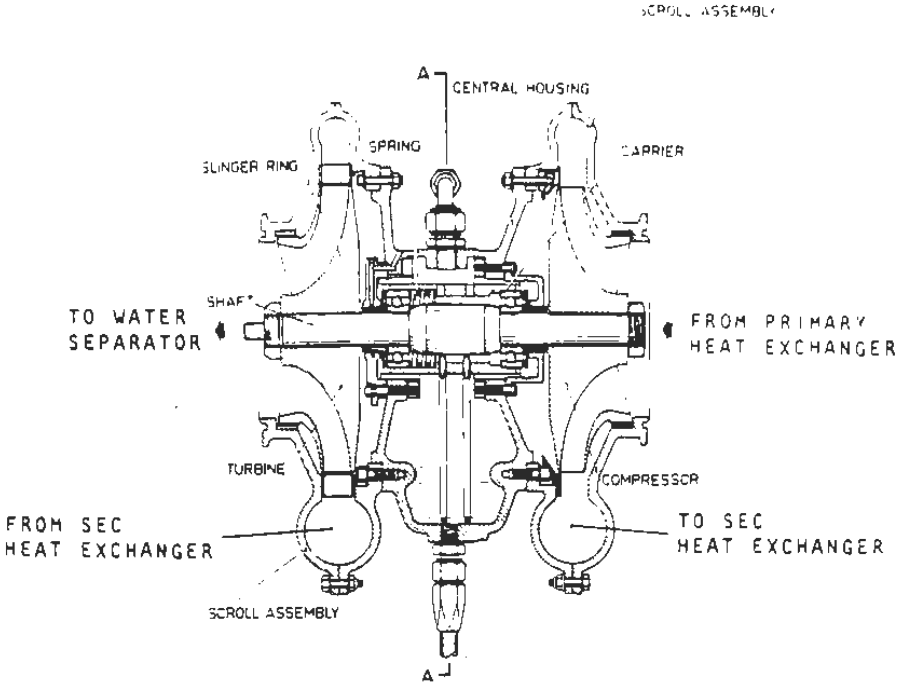
CHOKE VALVE AND BY-PASS VALVE POSITION INDICATION SYSTEM

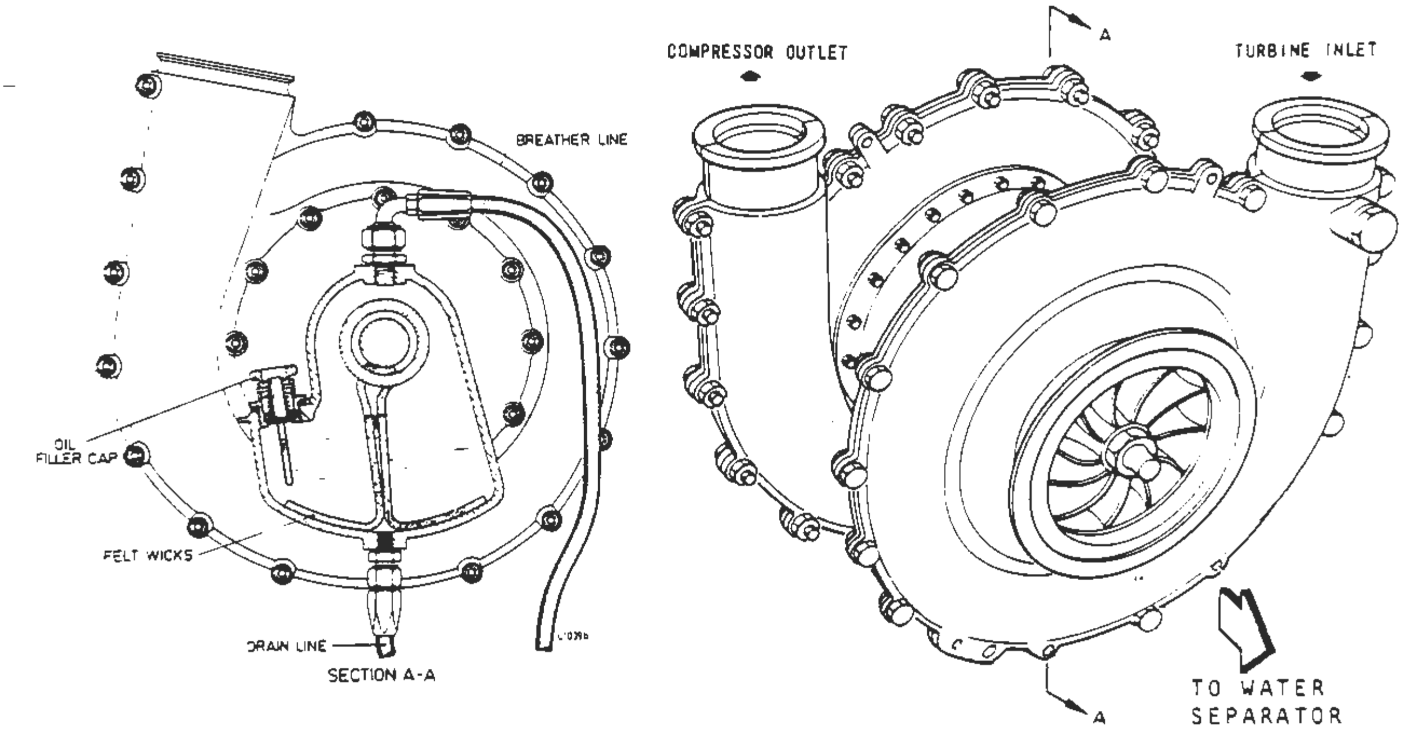




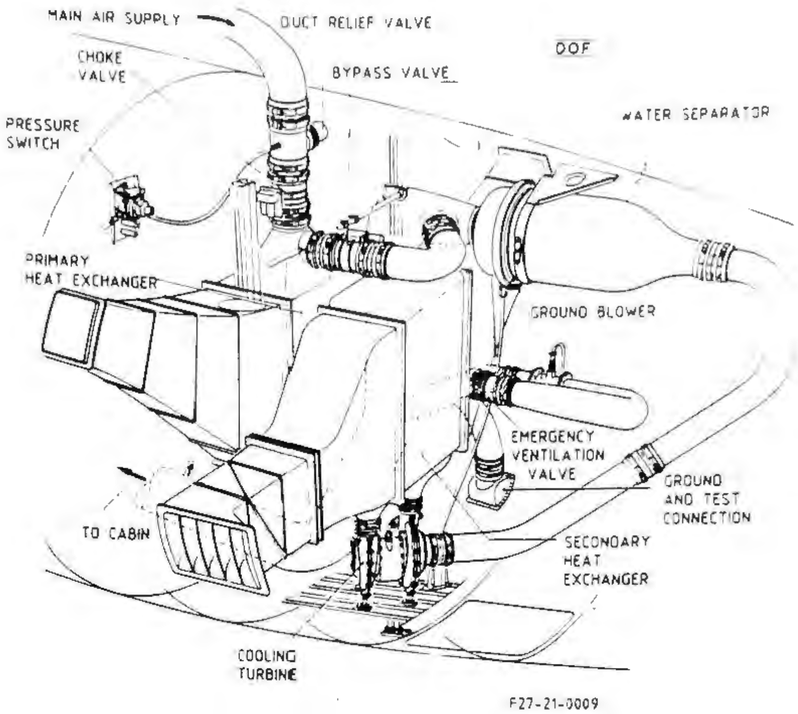


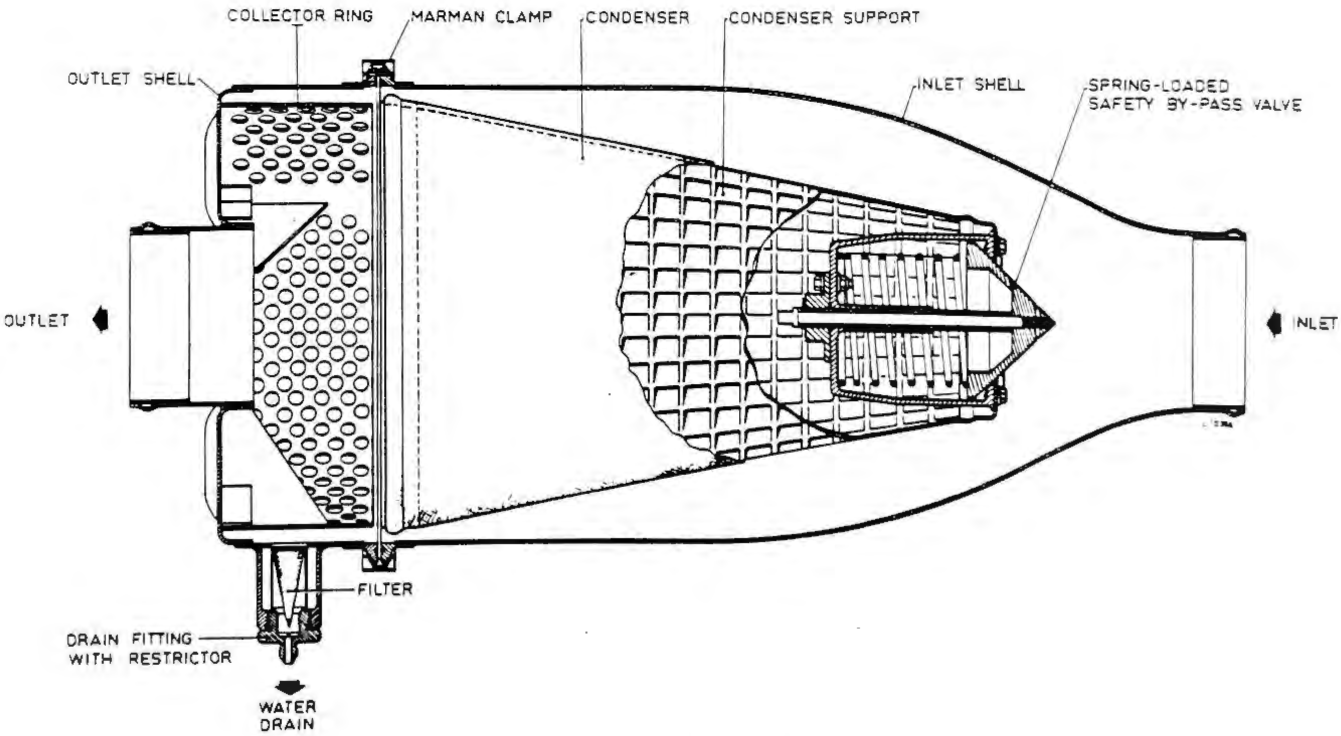
HEAT EXCHANGERS



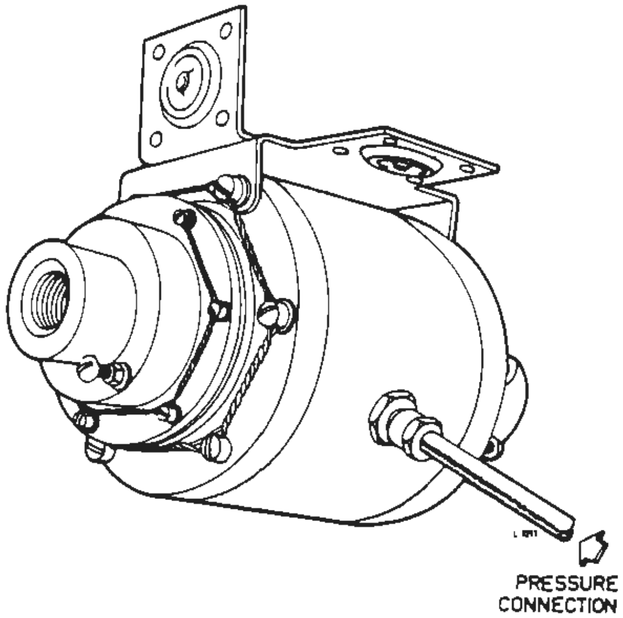


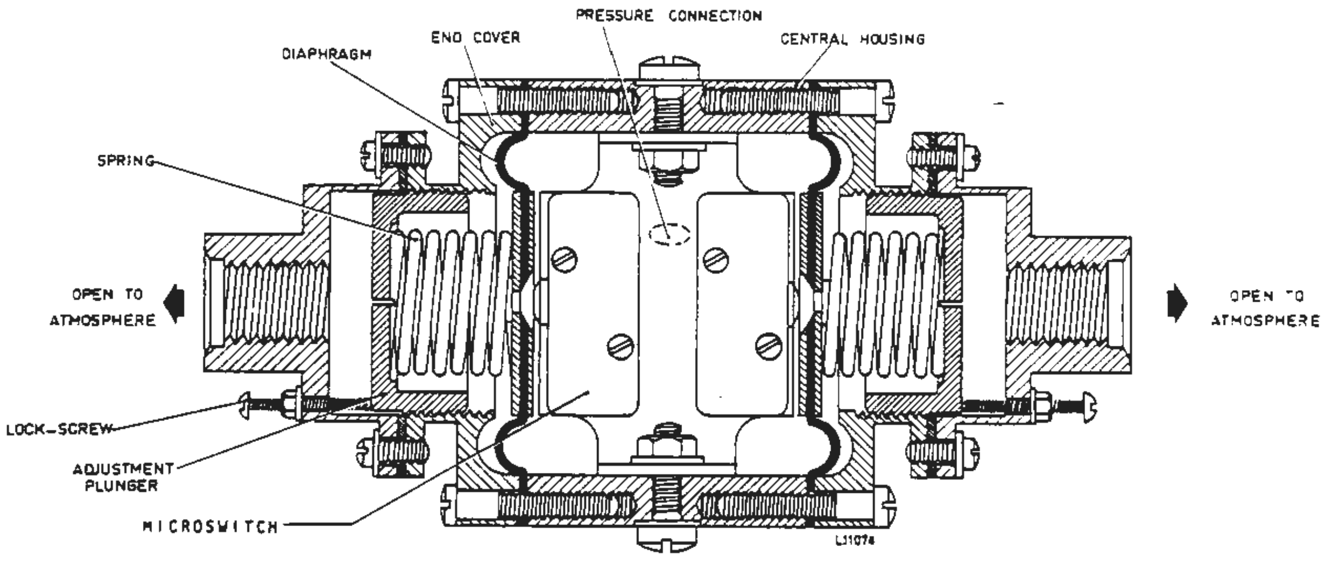
COOLING TURBINE



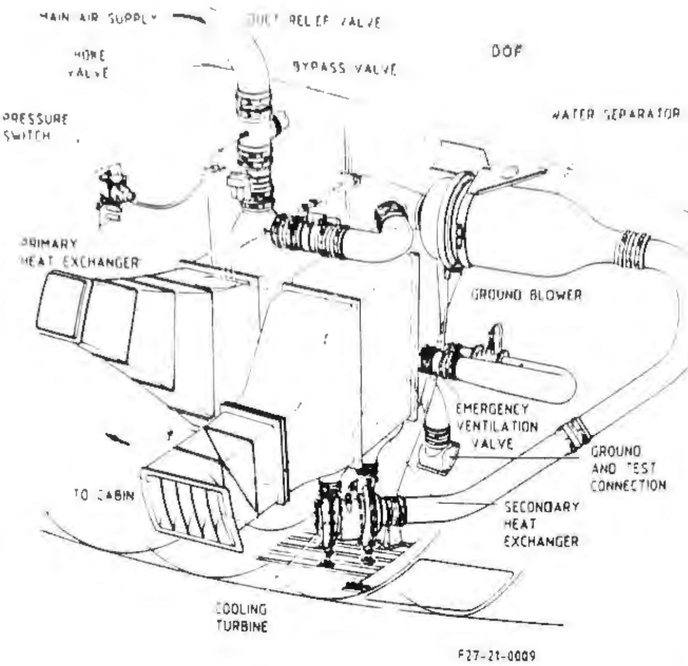


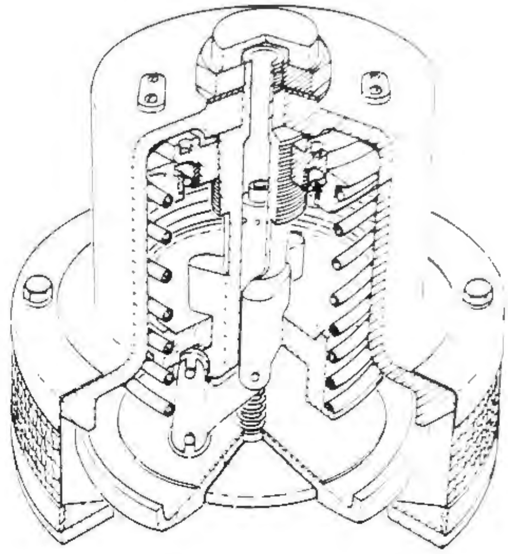
WATER SEPARATOR

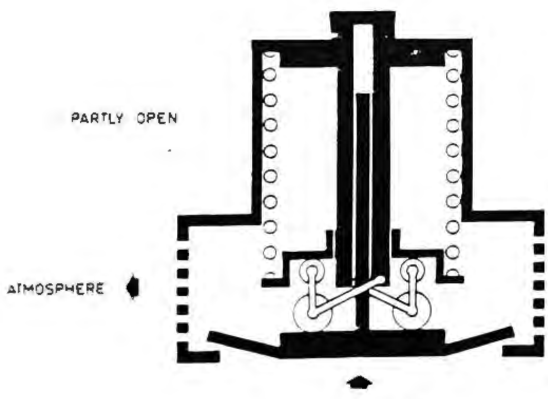


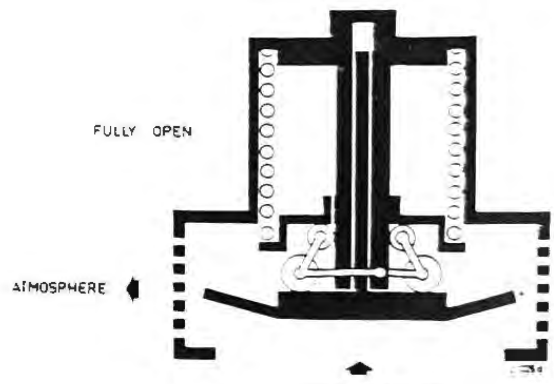


PRESSURE SWITCH

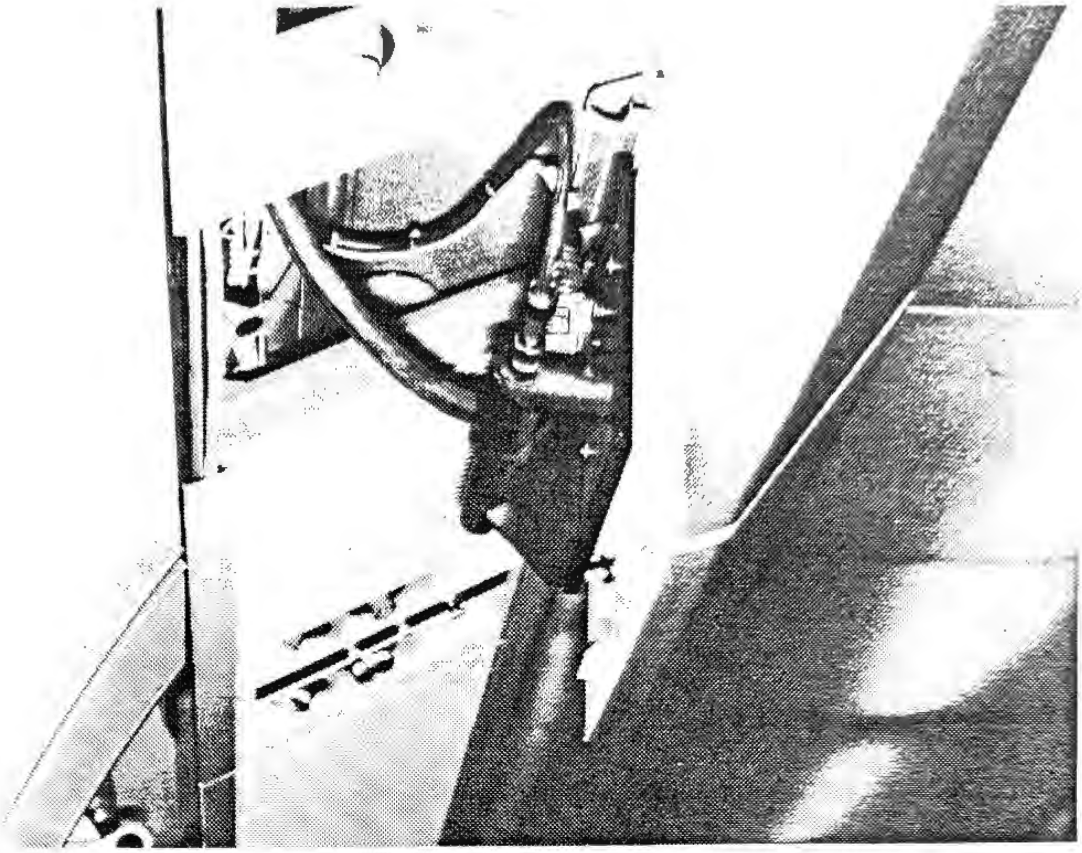


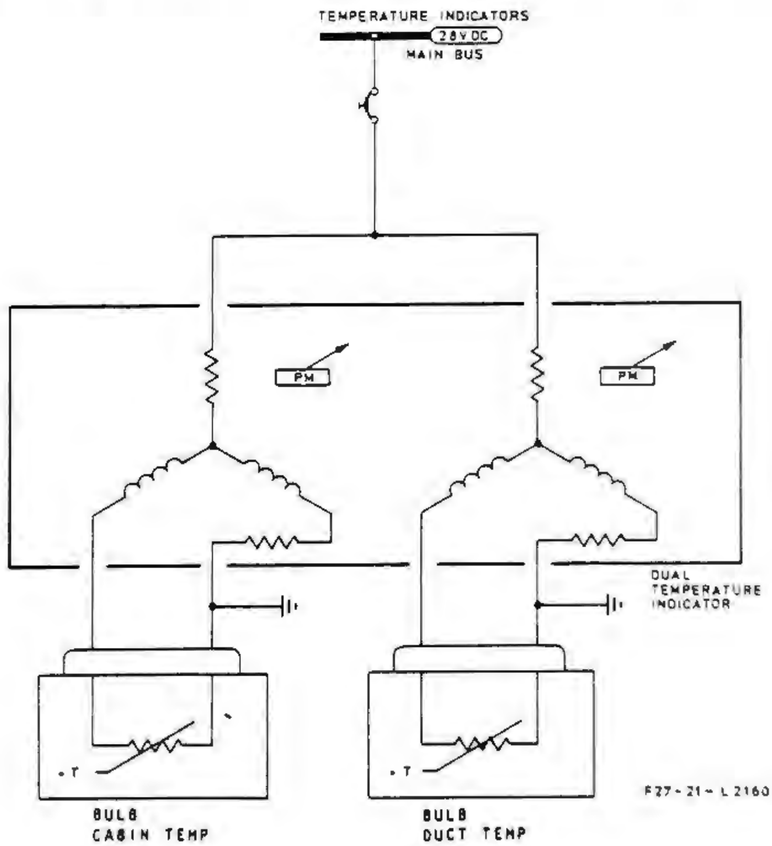




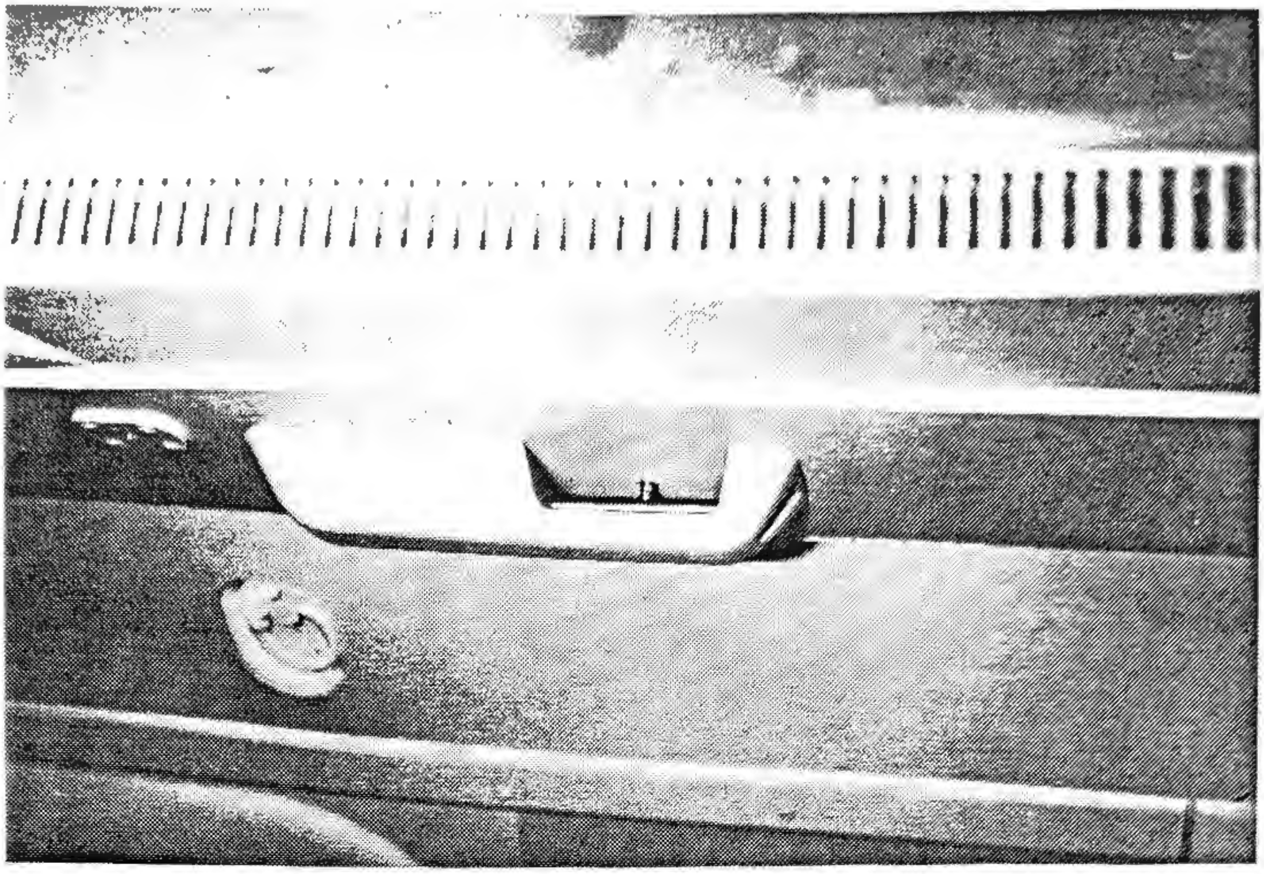


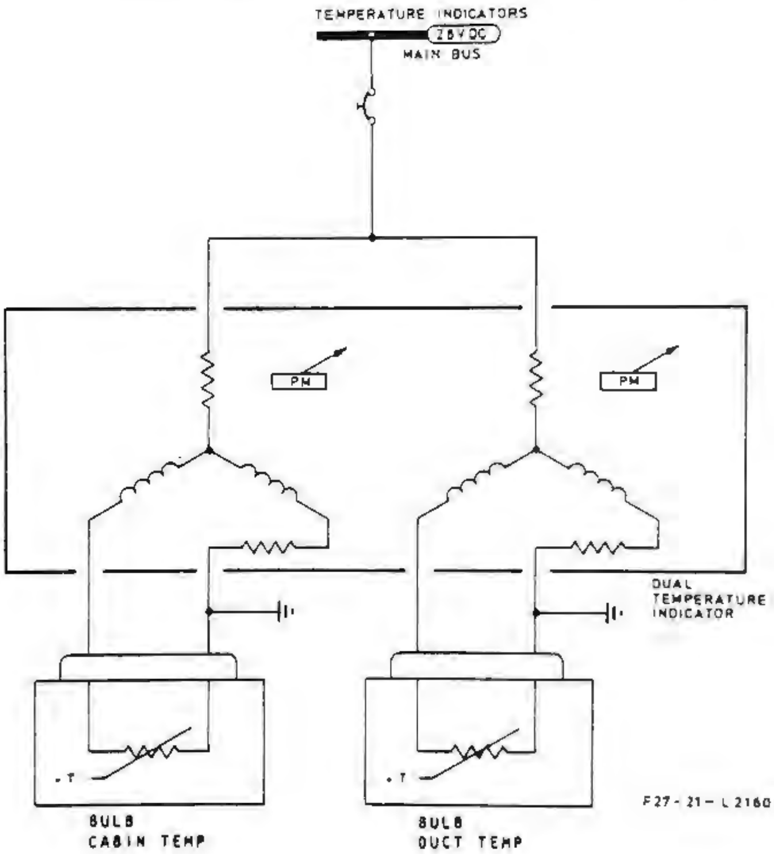
DUCT RELIEF VALVE





TEMPERATURE INDICATION SYSTEM





TEMPERATURE INDICATION SYSTEM TROOPSHIP

30.0 PRESSURIZATION CONTROL

The cockpit, cabin and the space immediately below these compartments are pressurized. The pressurization system controls the cabin pressure and limits the differential pressure between inside and ambient to 4.16 (5.5) psi, while ensuring a cabin pressure altitude of 8000 ft at a 20.000-ft aircraft altitude.
The cabin altitude can be selected on the cabin pressure controller on the RH side in the cockpit. The RATE control knob on the controller allows a selection of a gradual change of cabin pressure. During climb 500 ft/minute is selected, during descent 300 ft/minute.

Structurally an aircraft pressure hull is stressed for outward pressure cycles only. The pressure hull cannot resist greater outside than inside pressures, i.e. no negative differential pressure.

The prime requirements of the pressurization control are as follows:
- cabin pressure (cabin pressure altitude),
- rate of change of cabin pressure (cabin vertical speed),
- maximum differential pressure,
- maximum differential protection,
- negative differential protection.

- Cabin Altitude Control (selections between -1,000 ft and +10,000 ft).

The principle is based on controlling the amount of air leaving the cabin via two outflow valves.
When the input and output are the same the pressure remains constant.
When the output is more than the input the pressure in the cabin decreases and when the output is less than the input the pressure increases.

The outflow valves are controlled by the pressure in the control chamber. The higher the pressure in the control chamber the more the outflow valves are closing, the lower the pressure, the more the valves are opening.
The pressure signal for positioning the outflow valves is controlled by the cabin pressure controller or by a manually operated needle valve.

- Rate of Change (selections between 50 - 2,000 ft/minute)

The pressure signal coming from the cabin pressure controller determines the volume of the outflow. The rate of outflow determines in its turn the rate of change (vertical speed) of the cabin. The pressure signal can be selected by the RATE control knob on the cabin pressure controller.

- Differential Pressure Protection (4.16 (5.5) psi and 4.22 (5.65) psi)

The normal differential pressure is set to 4.16 (5.5) psi, and is controlled by a limiter located inside the cabin pressure controller.
This device limits the pressure signal when the cabin pressure differential reaches 4.16 (5.5) psi.
In case of malfunctioning of this 4.16 (5.5) psi limiter other limiters, one on each outflow valve, take over at 4.22 (5.65) psi and reduce the

control pressure in order to open the outflow valves.

- Negative Differential Pressure Protection

Each outflow valve acts also as a negative differential pressure limiter. Due to a negative differential pressure across the diaphragm inside the outflow valve, the valves open and ambient air can enter the cabin in order to prevent a negative differential pressure to build up.

NOTE: All figures between brackets are applicable for aircraft equipped with a small cargo door.

30.1 Outflow/Safety Valves

The two valves are mounted on the rear pressure bulkhead, cabin side. The two valves operate in parallel and are identical.

Operation as an outflow valve

The outflow poppet of the valve responds to the difference between cabin and control pressure. This differential pressure causes the poppet to open or close allowing cabin air to flow to atmosphere in an amount necessary to control the cabin pressure and the rate of change of cabin pressure.
The cabin pressure chamber is open to cabin. Cabin air enters the control chamber via an air filter and orifice (FILTER CONN).

When both control and cabin pressure are equal the outflow poppet is almost closed by action of a spring.
Control chamber pressure can be suct away when an underpressure is applied to the RELAY connection.
When the control pressure is below cabin pressure, cabin pressure pushes the outflow poppet to a more open position. When the suction is disconnected from the RELAY connection, cabin air re-enters the control chamber via the air filter and orifice and therefore the outflow poppet moves to a more closed position.

Operation as a safety valve

When the differential pressure exceeds 4.22 (5.65) psi, a pressure relief diaphragm opens a pressure relief metering valve. Control chamber pressure is then relieved to ambient and therefore the outflow poppet moves to a more open position. As a result the cabin pressure will drop and so does the differential.

NOTE: This safety operates as a back-up in case the differential pressure is not limited at 4.16 (5.5) psi by the cabin pressure controller.

Negative pressure relief occurs whenever atmospheric pressure exceeds the cabin pressure. When this condition exists, atmospheric pressure forces the outflow poppet of its seat, allowing air to flow into the cabin.

30.2 Venturi

The venturi provides a reference pressure lower than ambient pressure. The venturi is secured to the LH bottom part of the fuselage just before the rear pressure bulkhead.

Cabin pressure enters the venturi inlet and passes through the throat to atmosphere. Passage of air through the throat of the venturi reduces the pressure in the throat. The reduced pressure is used as a reference pressure lower than atmospheric pressure for the outflow valves.

30.3 Pneumatic Relays

The pneumatic relays operate as gates, controlled by the cabin pressure controller (automatically) or by the needle valve (manually), and control the amount of air pressure relieved from the control chamber and hence the volume of air that can pass via the outflow valve.

One side of the diaphragm of each relay is acting the signals coming from the cabin pressure controller or needle valve. On the other side are acting the signals from the control chamber of the outflow valve with cabin pressure via the orifice, and the venturi.
When the pressure in the reference chamber decreases, the diaphragm moves in such a direction opening the metering valve. The air in the control chamber of the outflow valve is now suct away by the venturi and therefore the outflow valve opens more.
The pneumatic relays are located in front of the outflow valves.

30.4 Dump Control Valves

The electrically-operated valves are used to allow full low reference-pressure of the venturi to suct away all air in the control chamber of the outflow valves which therefore open fully.
The valves are located near the outflow valves.

When the solenoid is energized, a magnetic field pulls an armature assembly away from the valve seat, allowing air to flow from outflow valve to venturi.
When the solenoid is de-energized, a compression spring returns the armature assembly to the valve seat thus closing off all flow.

The solenoids are manually energized via the DUMP control switch or automatically via the RH landing gear shock strut switch.

30.5 Cabin Pressure Controller

The cabin pressure controller, which is located on the RH side panel in the cockpit, produces signals to the outflow valves in order to control the cabin pressure.

Cabin altitude is controlled by turning the CABIN ALT selector knob until the pointer indicates the required altitude on the dial. The maximum aircraft altitude for the selected cabin altitude is shown in the centre sub-scale on the dial face. The rate at which cabin altitude climbs is

set by turning the RATE control knob to the required value.

Unpressurized Operation

Before operation, pressures on both sides of the rate control diaphragm are equalized at existing atmospheric pressure. This condition compresses the isobaric bellows and opens the isobaric metering valve, provided the cabin altitude selection is higher than field altitude. Cabin air then flows through the cabin air filter and cabin air orifice into the reference pressure chamber, then out through the open isobaric metering valve to atmosphere. Reference chamber pressure from the RELAY connection, responding to a balance between outflow valve and venturi reference by way of the system pneumatic relay, produces an unpressurized cabin, provided that the rate of climb of the aircraft does not exceed the selected cabin rate of change.

Selective Pressure Rate of Change Operation

Starting from a stable condition with increasing (decreasing) cabin altitude at a certain rate of change selection.

Increasing (decreasing) of the cabin altitude means a decrease (increase) of the cabin pressure, so the outflow valve must be opened (closed) more.
The opening (closing) of the outflow valve is performed by changing the balance between isobaric bellows and spring tension assembly in the cabin pressure controller.
The result of changing this balance is that the metering valve moves to a more open (close) position so the pressure in the reference pressure chamber is reduced (increased).
Due to the fact that the rate control chamber is connected to the reference pressure chamber by an adjustable orifice (RATE control knob), the pressure in the rate control chamber will reduce (increase) as well, but at a predetermined rate by setting the RATE control knob.
A pressure differential across the rate control diaphragm, created by the metered equalization, will close (open) the metering valve against the cabin altitude selection signal (unbalance of bellows and spring).
At the moment that the differential pressure across the rate control diaphragm is equalized the metering valve opens (closes) again (selected cabin altitude reached).

Isobaric Operation

As the cabin pressure approaches the isobaric operating altitude, the isobaric bellows expands sufficiently to assume control of the isobaric metering valve. With reference chamber pressure acting on the pneumatic relay maintained essentially constant by the isobaric control system, and outflow valve control and venturi pressures acting on the pneumatic relay remaining constant, any variation in cabin pressure will immediately affect the pneumatic relay, causing actuation of the outflow valve to control cabin pressure at the selected altitude.

Differential Operation

The differential control limits the differential pressure when the

differential pressure between the reference pressure chamber and atmosphere exceeds 4.16 (5.5) psi, the differential pressure diaphragm opens the differential metering valve and reference chamber air is released to atmosphere.

30.6 Needle Valve

This valve ensures in case of failure of the cabin pressure controller a manually-selected rate of airflow in the sensing line from the pneumatic relays to the venturi. The needle valve is located on the RH side panel in the cockpit.

When the valve is opened, air from the pneumatic relays enters the INLET connection in the side of the valve housing and flows through the valve seat opening and out the ATMOS connection to a venturi-shaped fairing causing a lower than reference pressure in the reference chamber of the pneumatic relays resulting in opening of the outflow valve.

The valve is operated by turning the knob on top of the valve counter clockwise to open the valve. To open the valve fully from the closed position requires approximately seven complete turns. A pointer on top of the knob gives an indication of internal valve position. The pointer is approximately 45 degrees, clockwise from the INLET connection when air begins to flow through the valve.

Further clockwise rotation of the valve shaft, after the valve is seated, compresses the spring in the end of the valve shaft; this prevents manual jamming of the valve on its seat.

The valve is wire locked in the closed position.

30.7 Selector Valve

For test purposes of the pressurizarion control system a selector valve with positions AUTO-MANUAL-TEST is fitted in the cockpit on the RH side panel. The valve can be used for testing the maximum differential pressure 4.16 (5.5) psi and 4.22 (5.65) psi.
When selected to TEST it isolates the cabin altitude selection part of the cabin pressure controller and when the aircraft is pressurized (on the ground) at a differential of 4.16 (5.5) psi the differential limiter starts controlling the cabin pressure to a differential of 4.16 (5.5) psi maximum.

When the valve is selected to MANUAL the entire cabin pressure controller is isolated (including the 4.16 (5.5) psi limiter).
If the aircraft is pressurized (on the ground) and the differential pressure reaches 4.22 (5.65) psi the maximum pressure differential limiters on the outflow valves itself start controlling the differential pressure to 4.22 (5.65) psi maximum.

This test has to be carried out twice because there are two maximum differential limiters (one on each outflow valve), so each limiter must be isolated in turn by capping-off the ambient references.
After the test return the valve to the AUTO position.

30.8 Venturi-shaped Fairing

The venturi-shaped fairing is secured to the cockpit skin on the RH side. It is used to generate a slightly less than ambient pressure for use as a reference pressure in the cabin pressure controller and for the needle valve.

30.9 Air Filters

The filters are used to filter air entering cabin air sensing ports of the cabin pressure controller and outflow valves.

The two filters for the outflow valves are located at each outflow valve. The one for the controller behind the controller.

The air filter assembly consists of a filter element cartridge and an outlet connection. The filter element cartridge consists of a filter element and a nylon screen.

Air enters the filter assembly and passes through the filter element and nylon screen. The nylon screen prevents larger elements of foreign matter from entering the cabin air sensing port. The filter element prevents fine particles of foreign matter and tobacco tars from entering the cabin air sensing port.

30.10 Cabin Altitude Switch

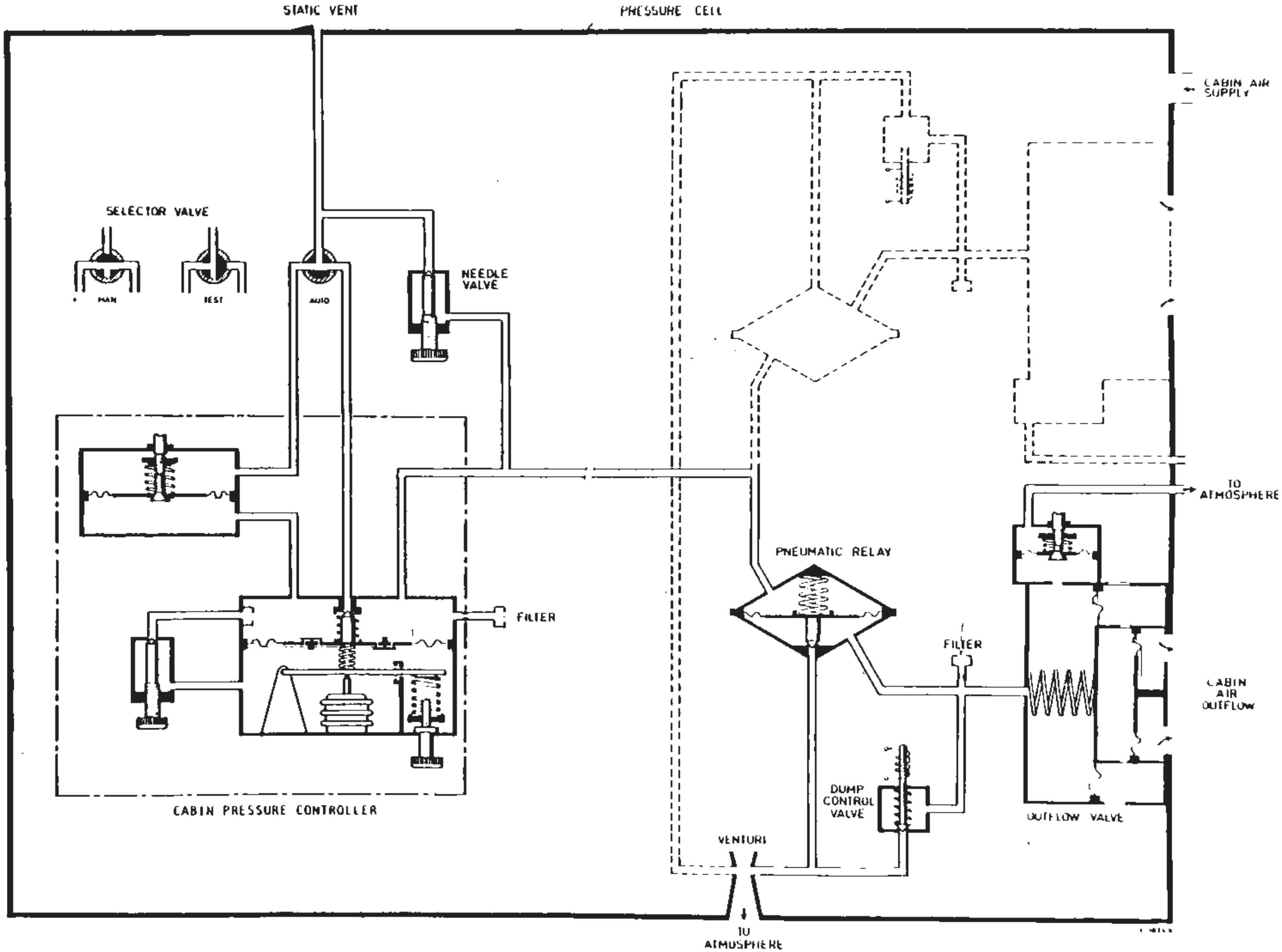
The altitude warning switch consists of a pressure capsule and a switch and is set to operate at 10,000-ft pressure altitude.

The switch is located behind the RH vertical side panel and makes a contact for the cabin pressure lights on the RH side panel and glare shield panel, if applicable, when the cabin altitude is above 10,000 ft.

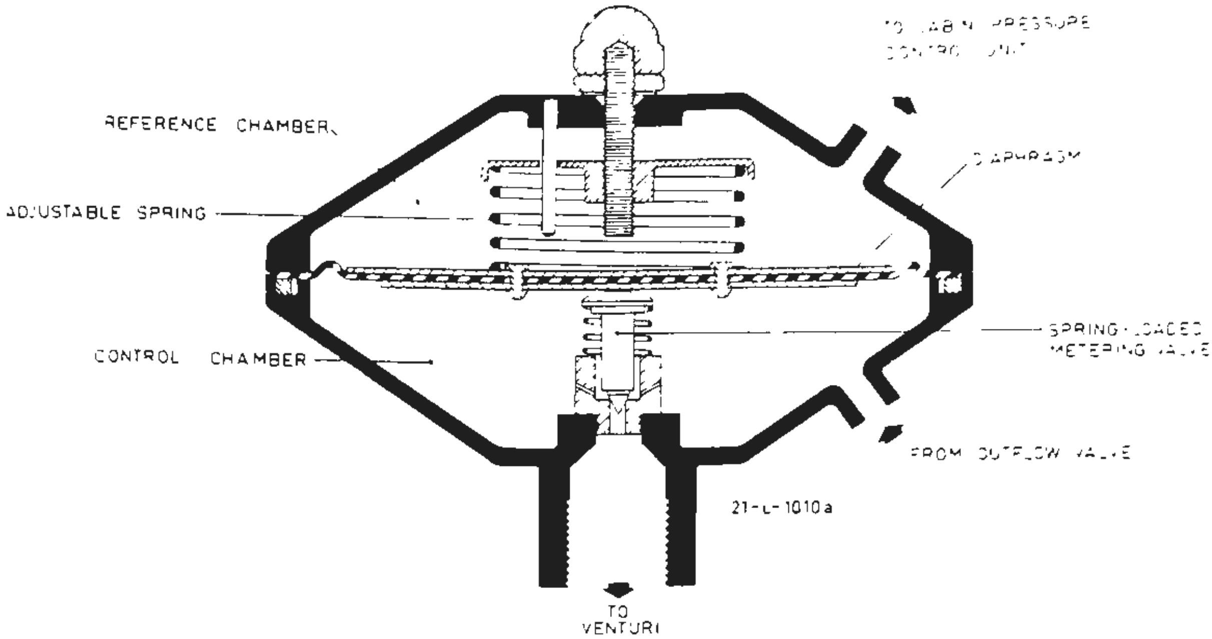
30.11 Cabin Vertical Speed, Cabin Altitude and Differential Pressure Indicator

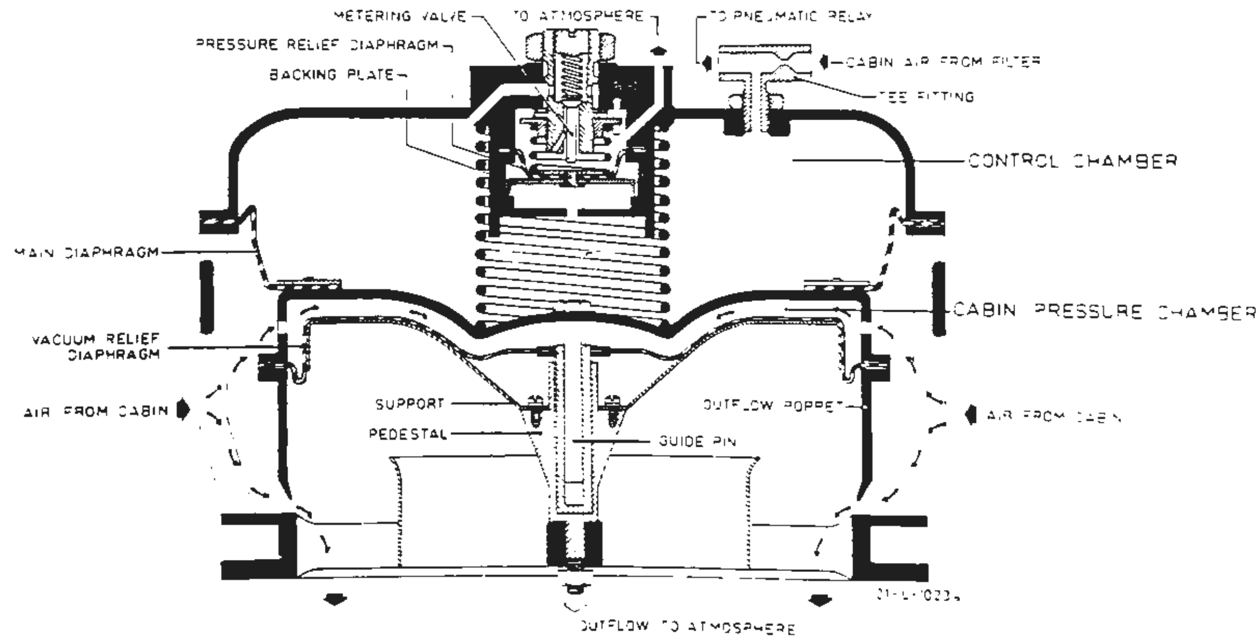
This indicator is located on the RH side panel:
- Cabin vertical speed part has a range from -2000 to +2000 ft/minute. The dial has markings at 100 ft/minute intervals and major graduations at 500 ft/minute intervals.
- Cabin altitude part has a range from 0 to 40.000 ft.
- Differential pressure part uses the same scale as used for the cabin altitude.

END

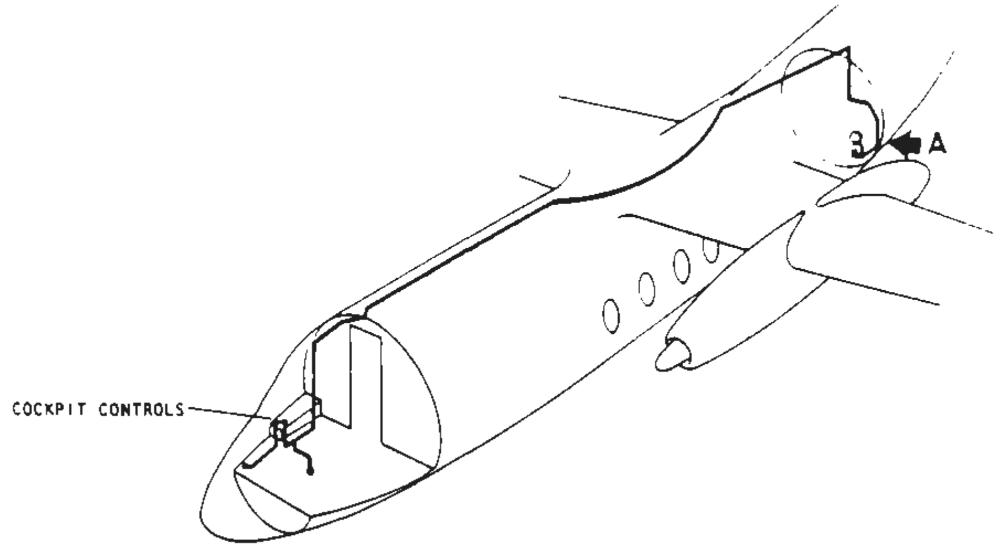


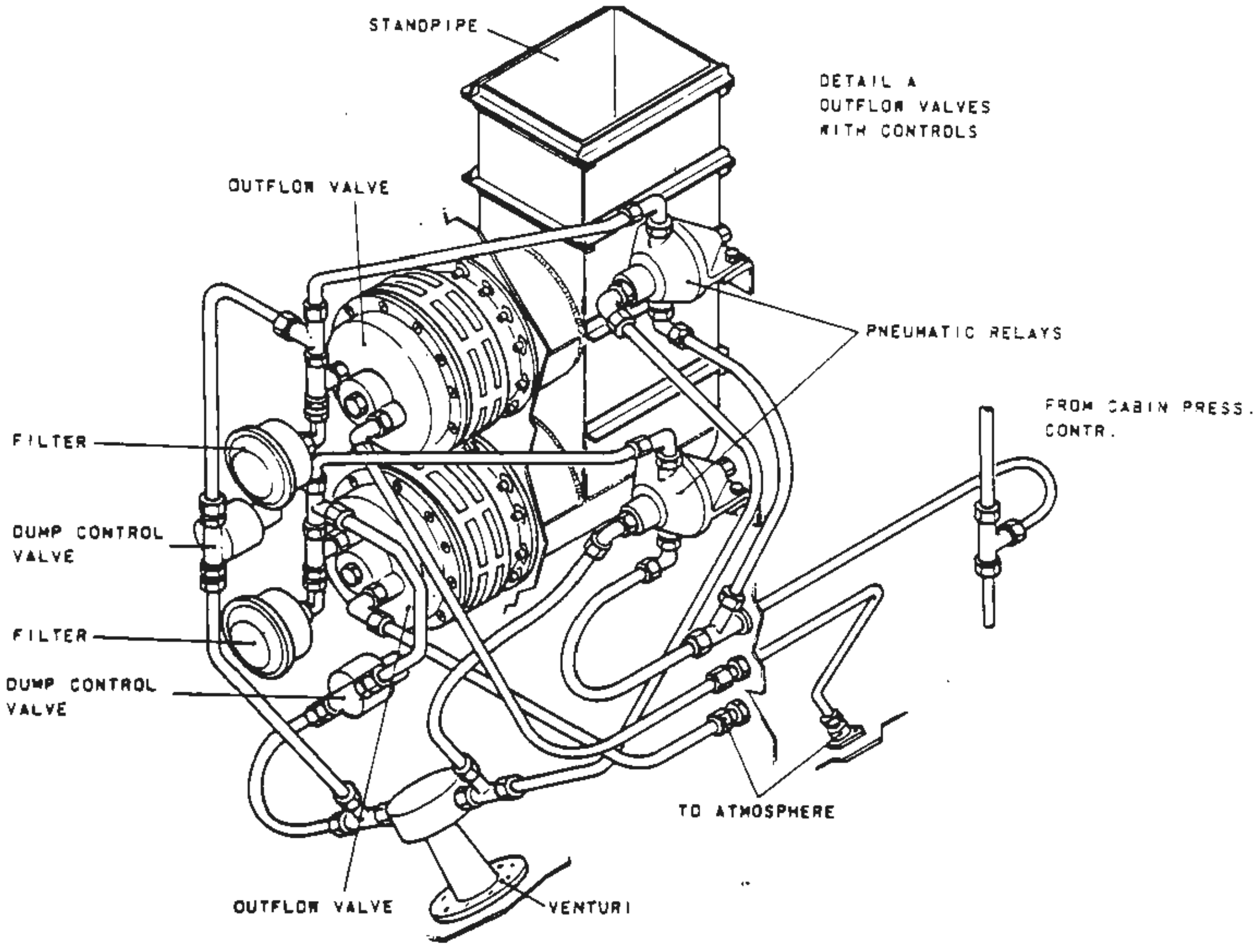
CABIN PRESSURIZATION SYSTEM





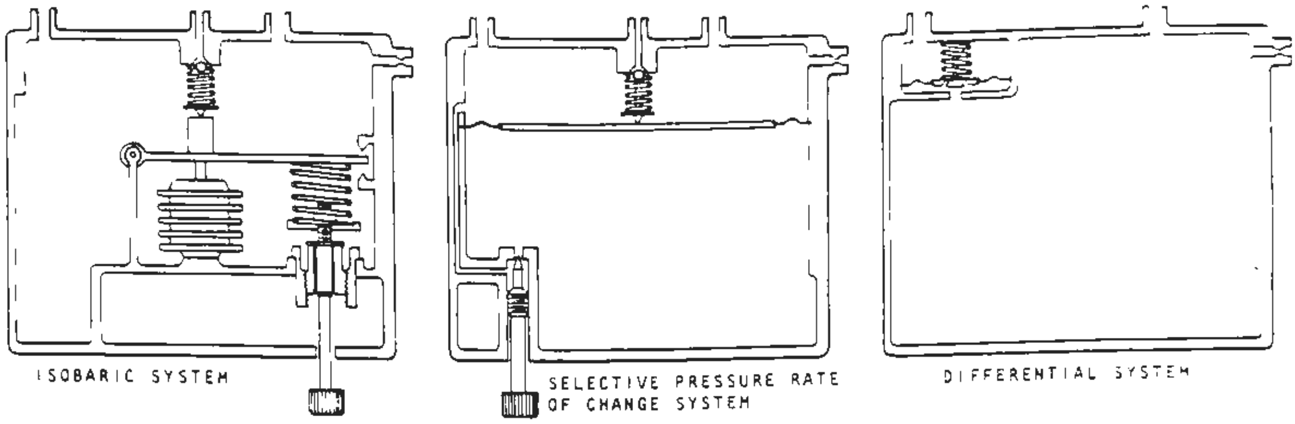
OUTFLOW / SAFETY VALVE

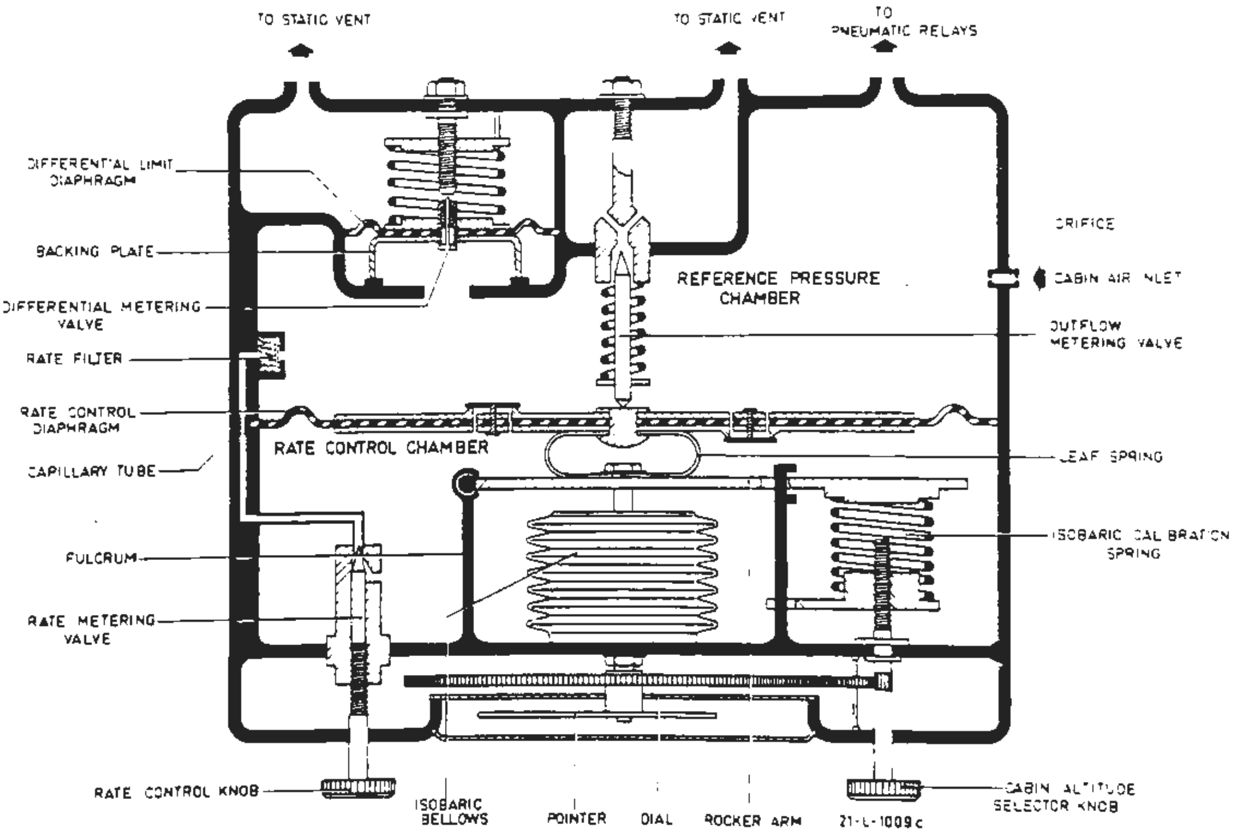




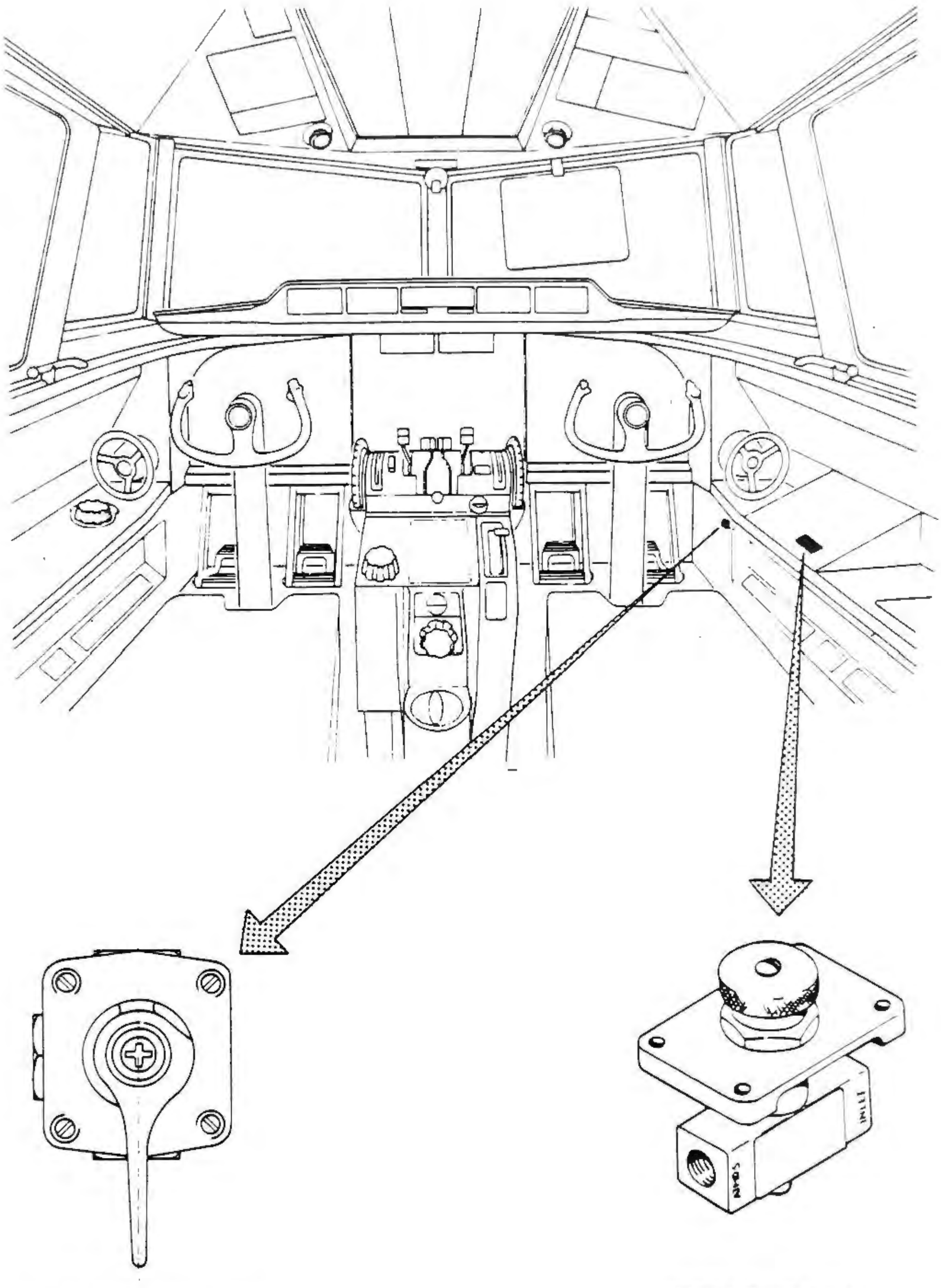
VIEW A

INSTALLATION OF OUTFLOW VALVES



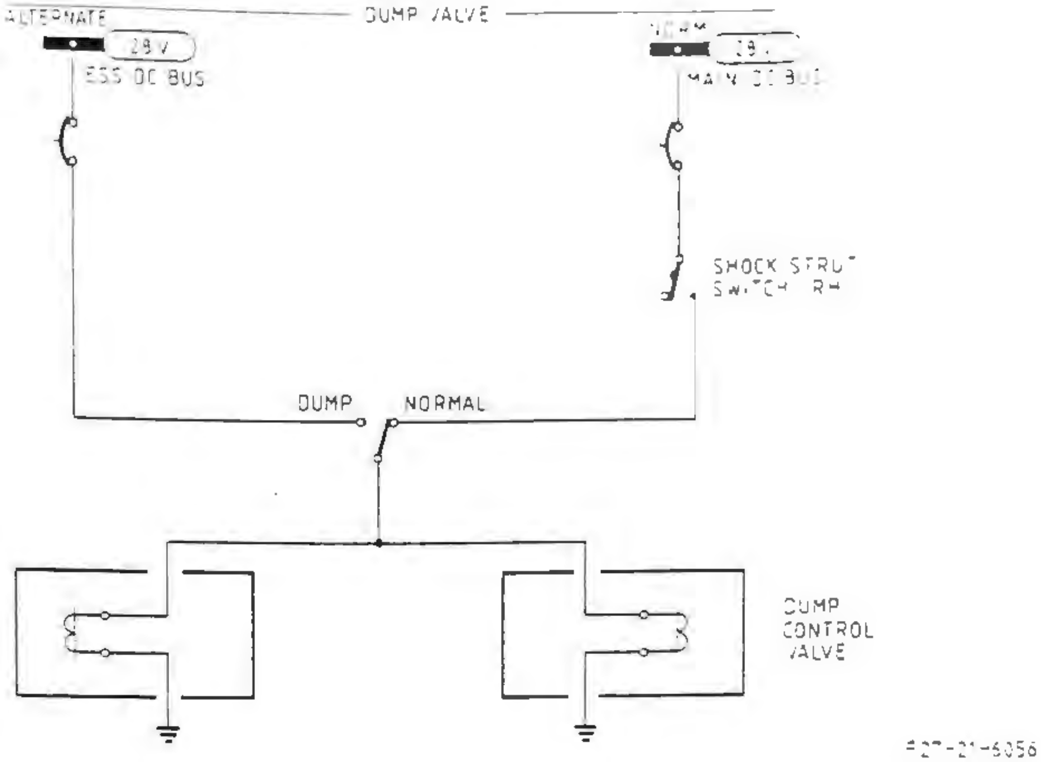


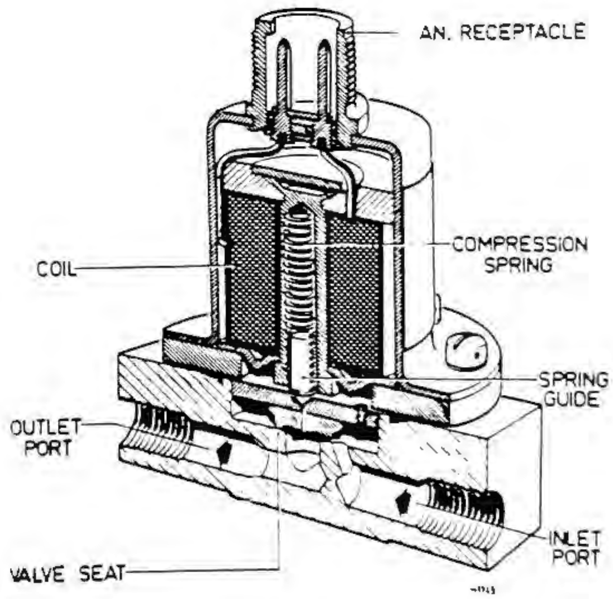
CABIN PRESSURE CONTROLLER



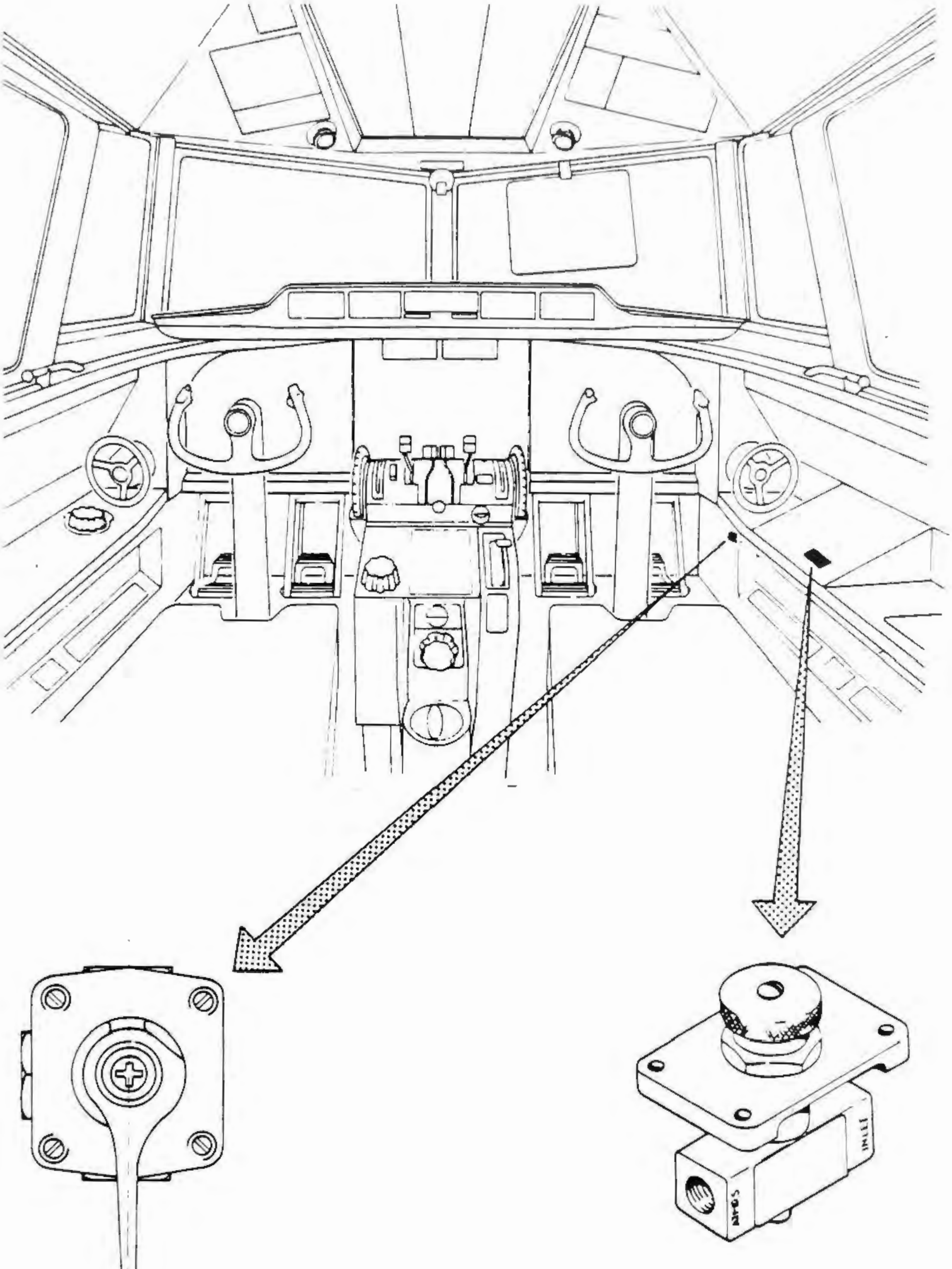
SELECTOR VALVE

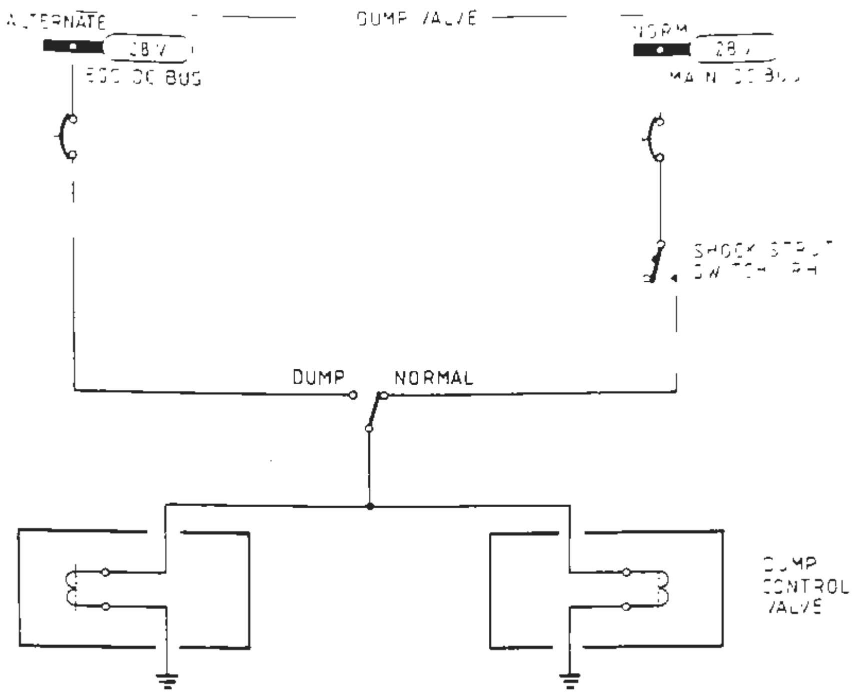
NEEDLE VALVE

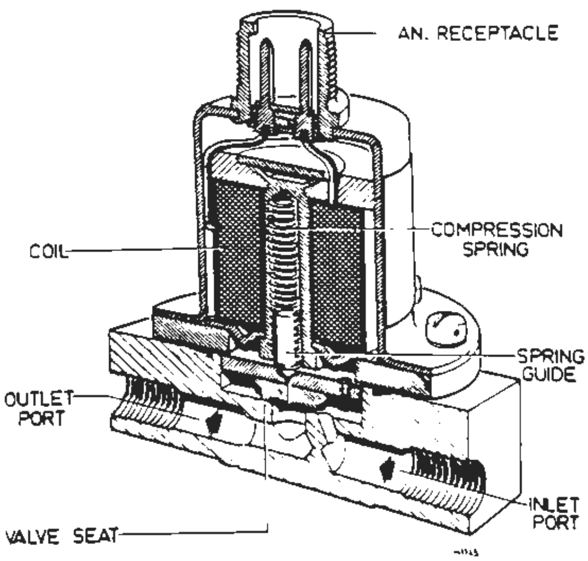




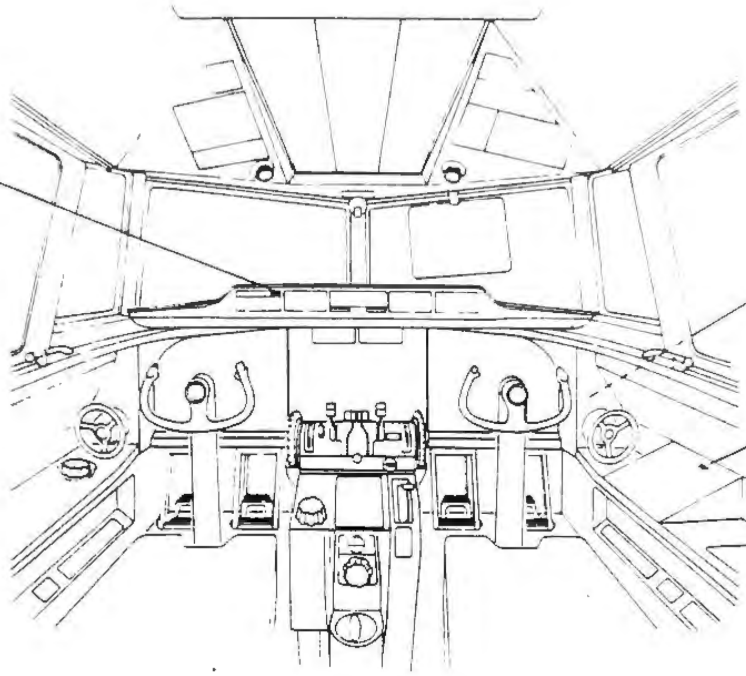
DUMP CONTROL VALVE

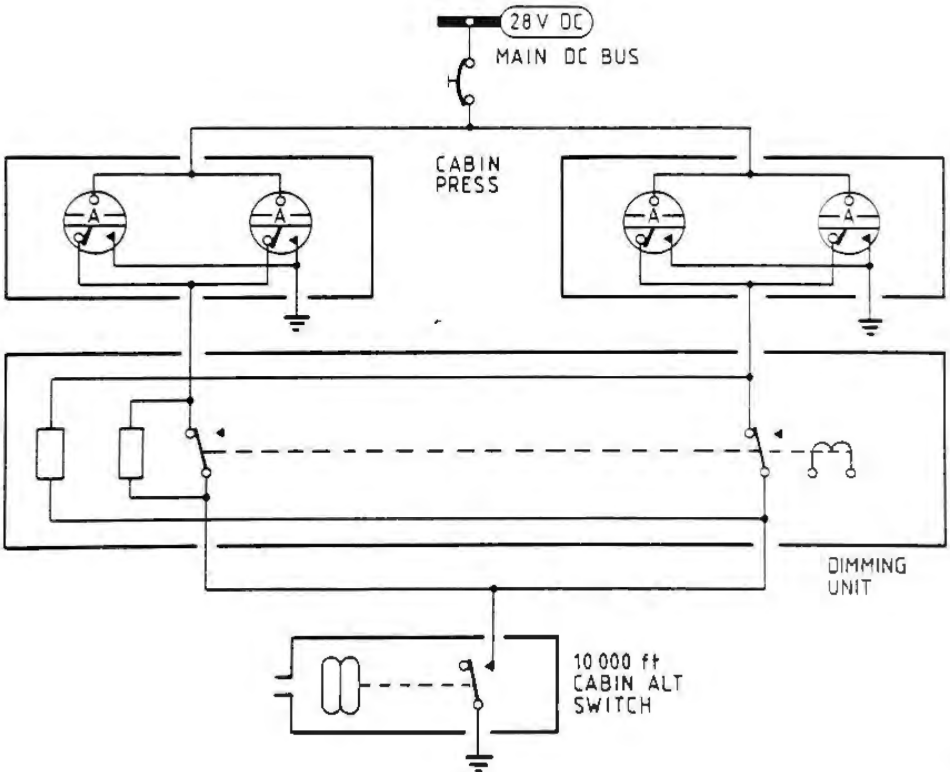

SELECTOR VALVE
NEEDLE VALVE



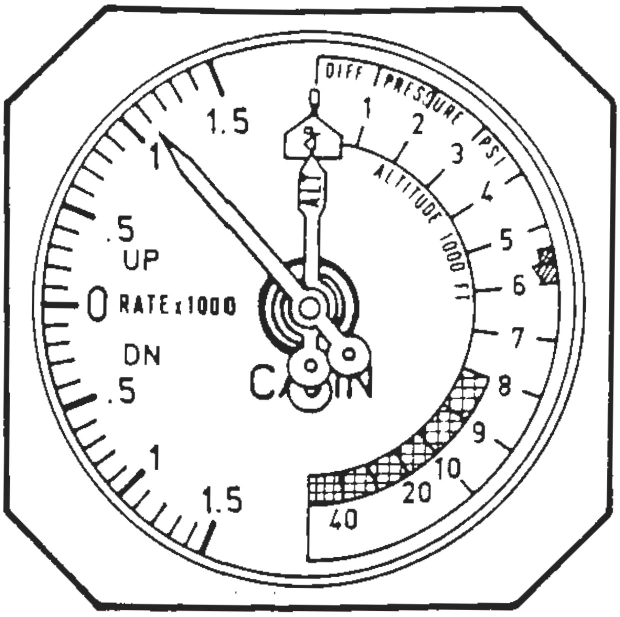


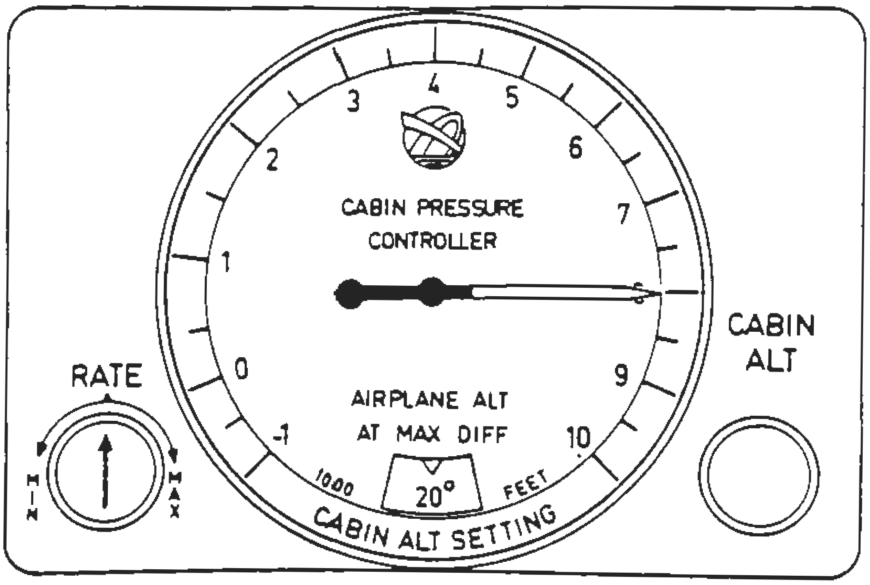
DUMP CONTROL VALVE



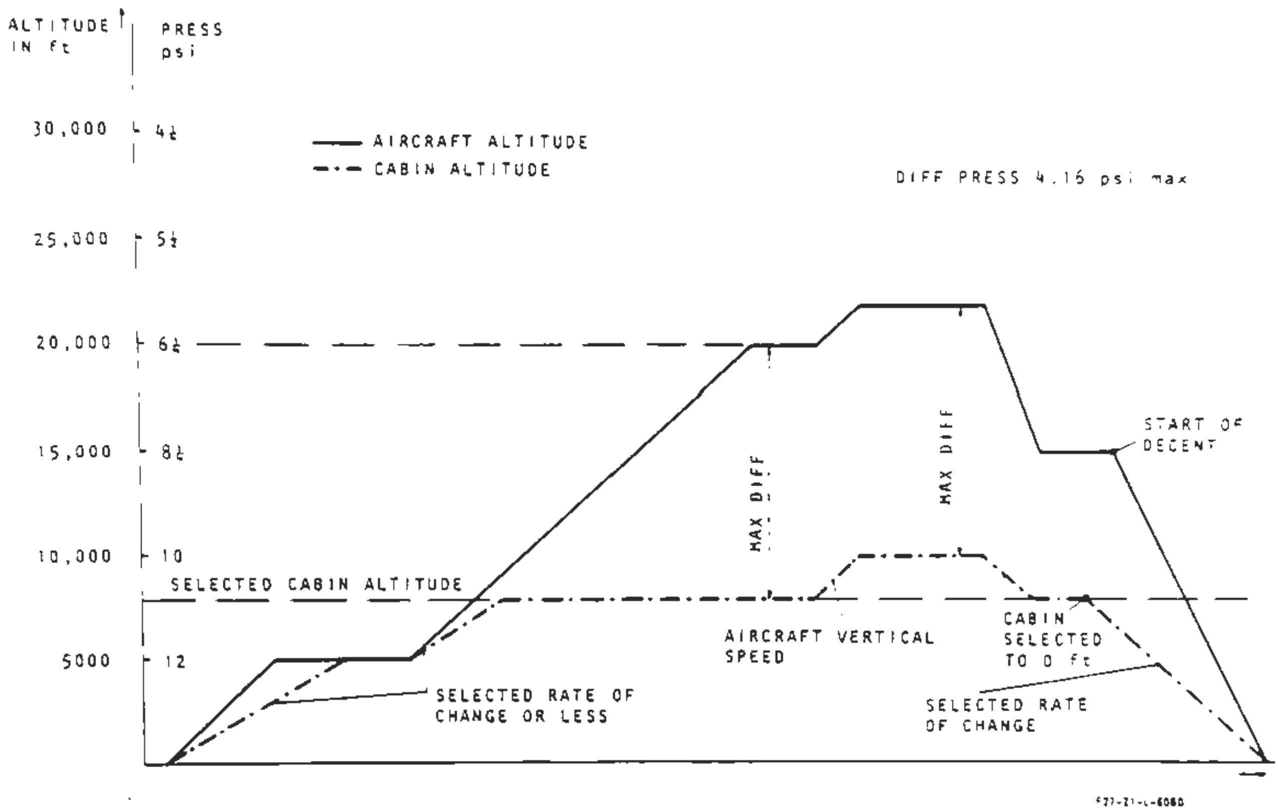


CABIN ALTITUDE CAUTION





PRESSURIZATION CONTROLS AND INDICATORS



TYPICAL PRESSURIZATION SCHEDULE

Altitude (ft)	Pressure		Altitude (ft)	Pressure	
	psi	In. Hg.		psi	In. Hg.
0(S-L)	14.70	29.92	16,000	7.96	16.22
1,000	14.17	28.86	17,000	7.65	15.57
2,000	13.66	27.82	18,000	7.34	14.94
3,000	13.17	26.82	19,000	7.04	14.34
4,000	12.69	25.84	20,000	6.75	13.75
5,000	12.23	24.90	21,000	6.47	13.18
6,000	11.78	23.98	22,000	6.21	12.64
7,000	11.34	23.09	23,000	5.95	12.11
8,000	10.92	22.22	24,000	5.70	11.60
9,000	10.50	21.39	25,000	5.45	11.10
10,000	10.11	20.58	26,000	5.22	10.63
11,000	9.72	19.79	27,000	4.99	10.17
12,000	9.35	19.03	28,000	4.78	9.72
13,000	8.98	18.29	29,000	4.57	9.30
14,000	8.63	17.58	30,000	4.36	8.89
15,000	8.29	16.89			

NOTE: 1 in. Hg. = 0.49 psi = 33.86 international millibars. 29.92 in. Hg. = 1013 millibars.

STANDARD ATMOSPHERIC PRESSURE

24 ELECTRICAL POWER

24. ELECTRICAL POWER

24. ELECTRICAL POWER

00.0 GENERAL

The F27 requires the following electrical power supplies:

- 28-V DC power, supplied by two engine-driven generators and two aircraft batteries. On the ground it can be supplied by a 28-V DC ground power unit (external power). For details refer to subchapter 24.30/40.
- 115-V, 400-Hz AC power, supplied by inverters. The avionics systems and instruments are supplied by main inverters, while for emergency an essential inverter is installed. For details refer to subchapter 24.22. The lighting systems requiring 115 V, 400 Hz are supplied by two more inverters. Refer to chapter 33.
- 120/208-V, variable frequency AC power, supplied by two engine-driven alternators. Refer to chapter 24.21.

The various consumers are fed from buses, which in turn are supplied by the sources.

All warning and caution lights, system control switches and indicators, such as voltmeters, frequency meters and ammeters are located on the LH and centre overhead panel in the cockpit.
Bus indicators on the centre overhead panel will illuminate (white) when their associated bus is supplied.
In case a red warning light comes on, the master warning light will come on too. Refer to chapter 33.

00.1 Wiring

The wiring diagram manual (WDM) contains wiring diagrams and schematics. A wiring diagram shows a complete system. The components are grouped in such a way that components, located in the same area are drawn together on the diagram. The components in the wiring diagram have their component identification code and an item number. The item number can be used to find the part number of the component. Refer to the equipment list in the WDM. Each wire in the wiring diagram has a wire identification code.

A schematic (page number 101 and up) shows also the system. However, less important components like splices, plugs, receptacles and terminal blocks are left out. The components are no longer grouped per area. The wire identification codes are abbreviated.

NOTE: The diagrams used in the training manual, chapter 24, are derived from the schematics of the WDM.

- Wire Identification Code
  This code comprises three groups of digits and one group of letters:
  - The first group consists of a 2-digit number, representing the location code.
  - The second group consists of a 2- or 3-digit number, the sequence number (wire number).

  - The third group consists of one or two letters, the system code.
  - The fourth group consists of a 2-digit number, the wire size.

- Component Identification Code
  This code comprises one group of letters and two groups of digits.
  - The first group consists of one or two letters, the system code.
  - The second group consists of a 2-digit number, the location code.
  - The third group consists of a 2- or 3-digit number, the sequence number (component number).

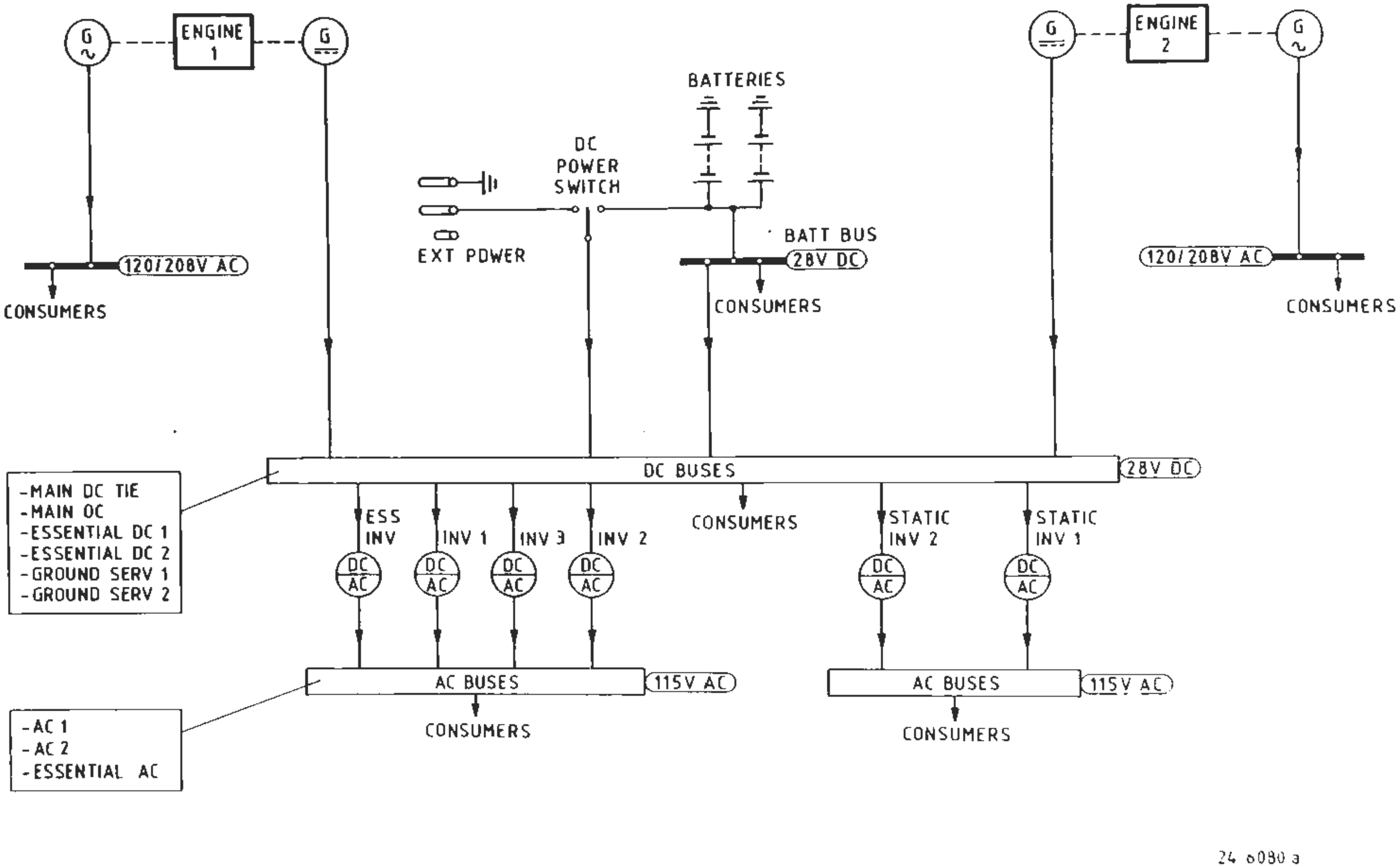
- Location Code

10 Fuselage, front section	21 Centre wing
11 Overhead panel, centre	22 Fuselage, centre section
13 Overhead panel, RH	23 Outer wing, LH
14 Main instrument panel panel	24 Outer wing, RH
15 Main junction box	25 Engine nacelle, LH
16 Glareshield panel	26 Engine nacelle, RH
17 Overhead panel, LH	27 Fuselage, rear section
18 Pedestal	44 De-icing relay panel

- System Code, Examples

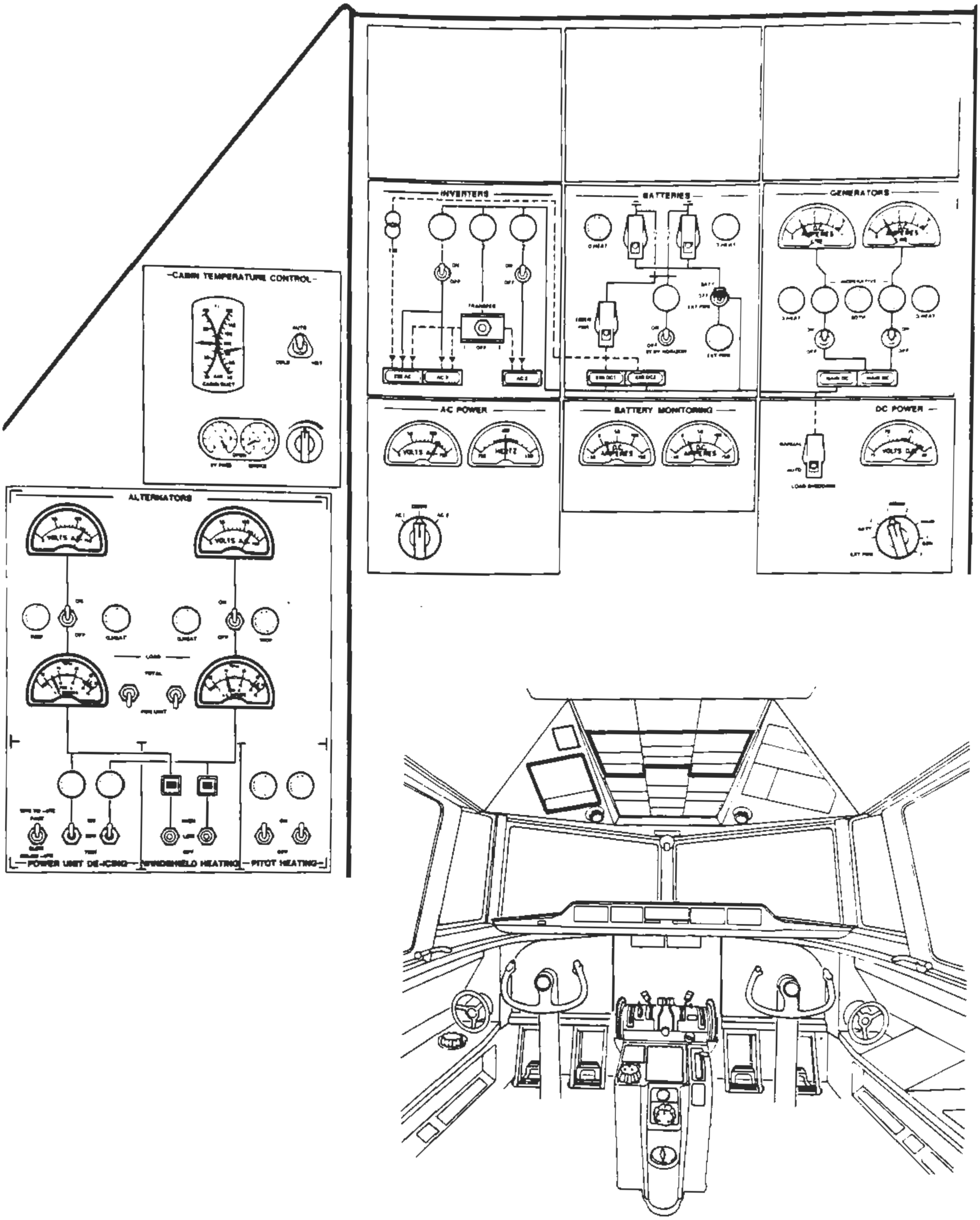
AA Electrical power, DC	F Avionics
AB Electrical power, inverters	K Autopilot
AD Electrical power, alternator	MA Fuel quantity indication
C Lights	SA Emergency lights
DC Air conditioning	TA Engine fire warning
EK Landing gear warning	

END



ELECTRICAL POWER, HOOK-UP

CODE 6



CONTROLS AND INDICATIONS

11 02 AA 20

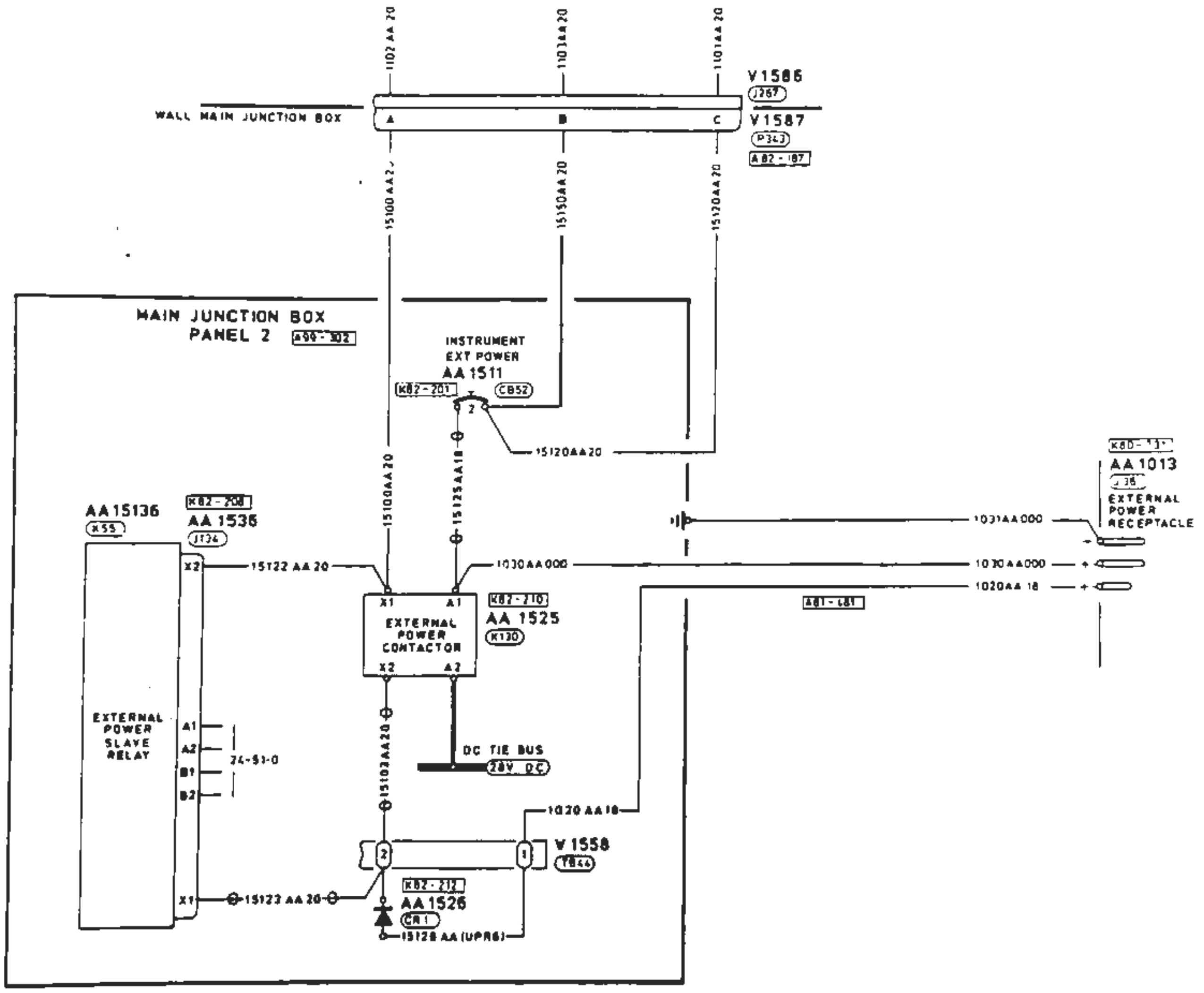
- 20 — Wire size
- AA — System code
- 02 — Sequence number
- 11 — Location code

Reference to W.D.M. Introduction

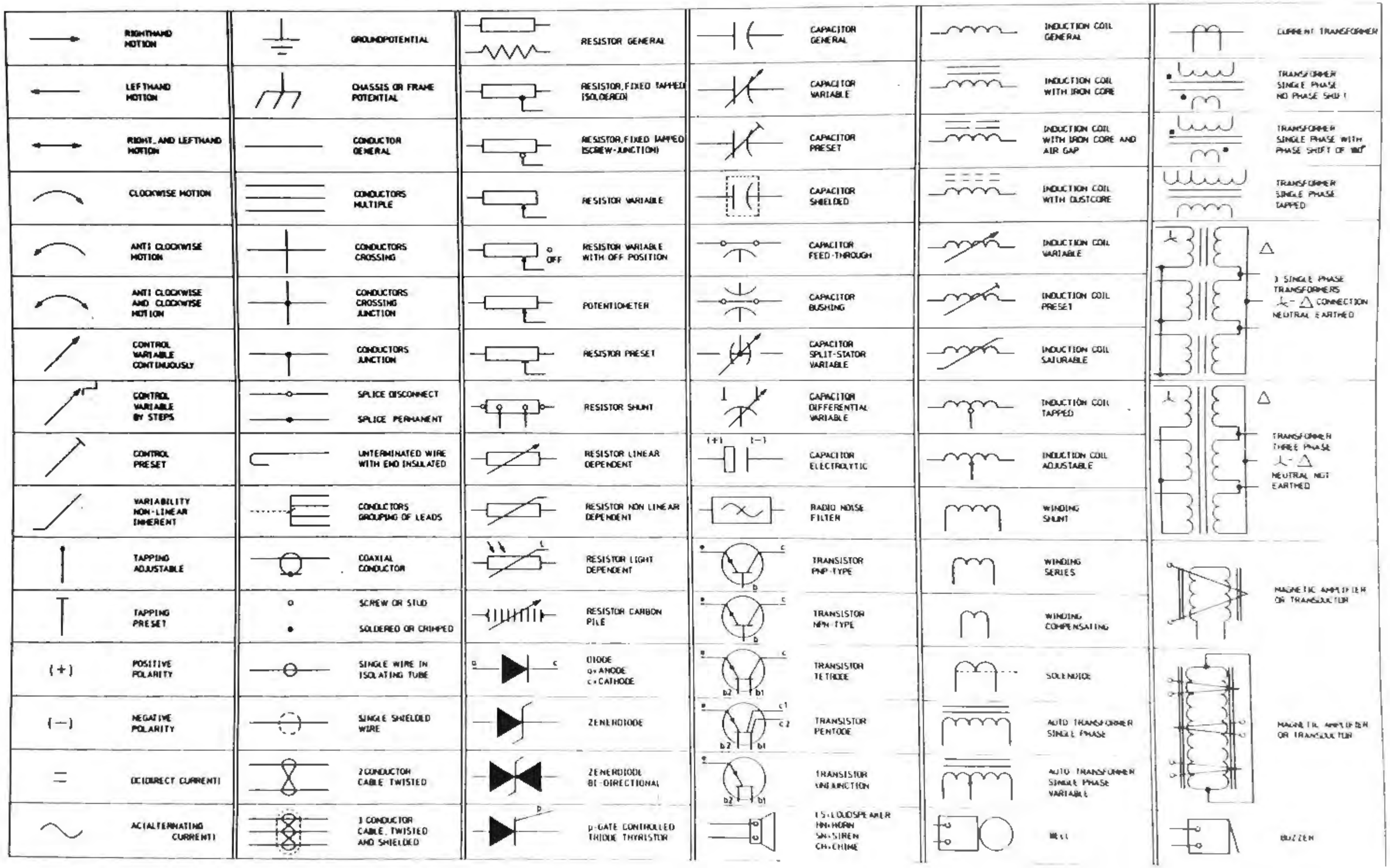
(K 130) → Itemnumber and Vendor

AA 1525

- 25 — Sequence number
- 15 — Location code
- AA — System code

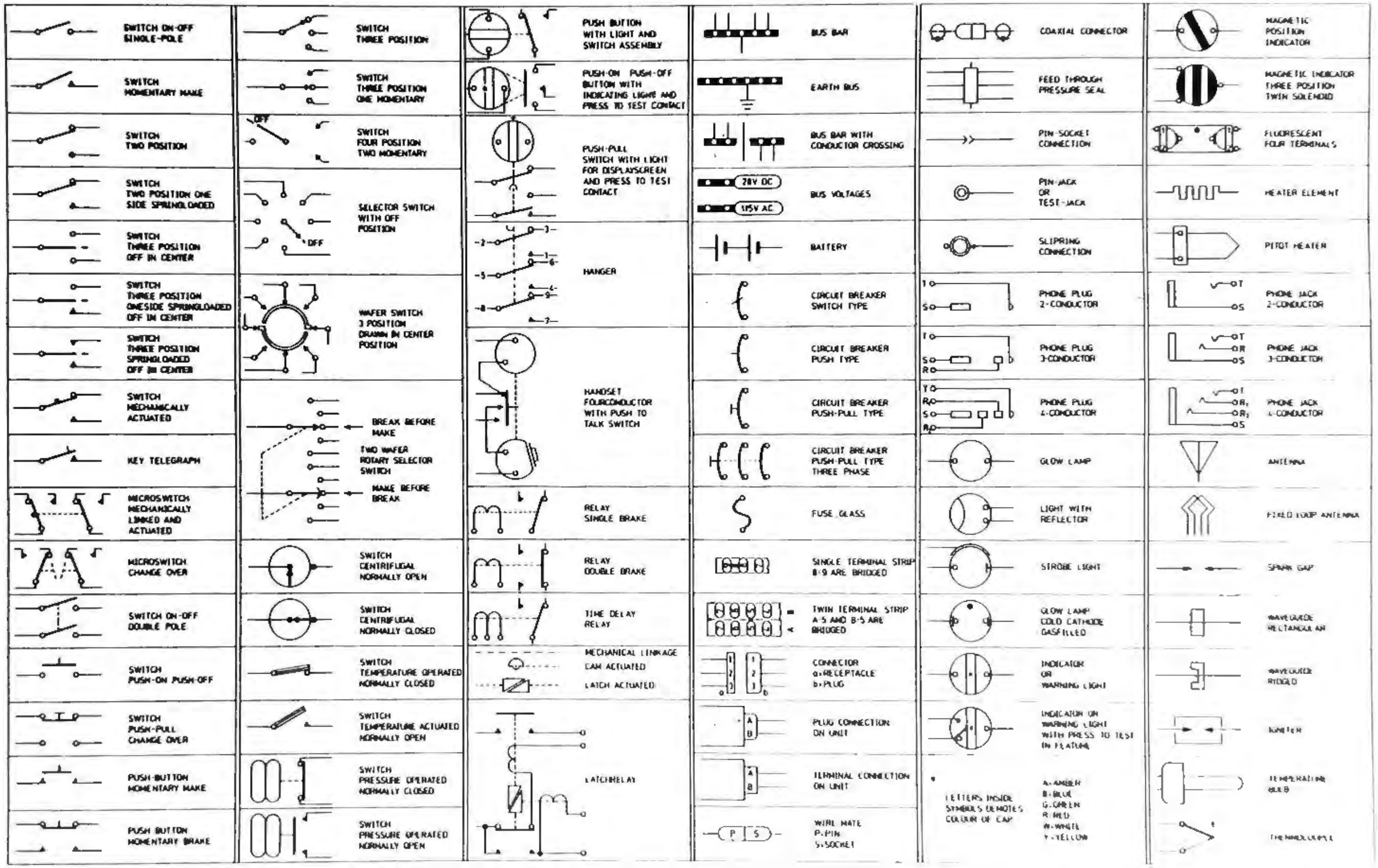


WIRE AND COMPONENT IDENTIFICATION



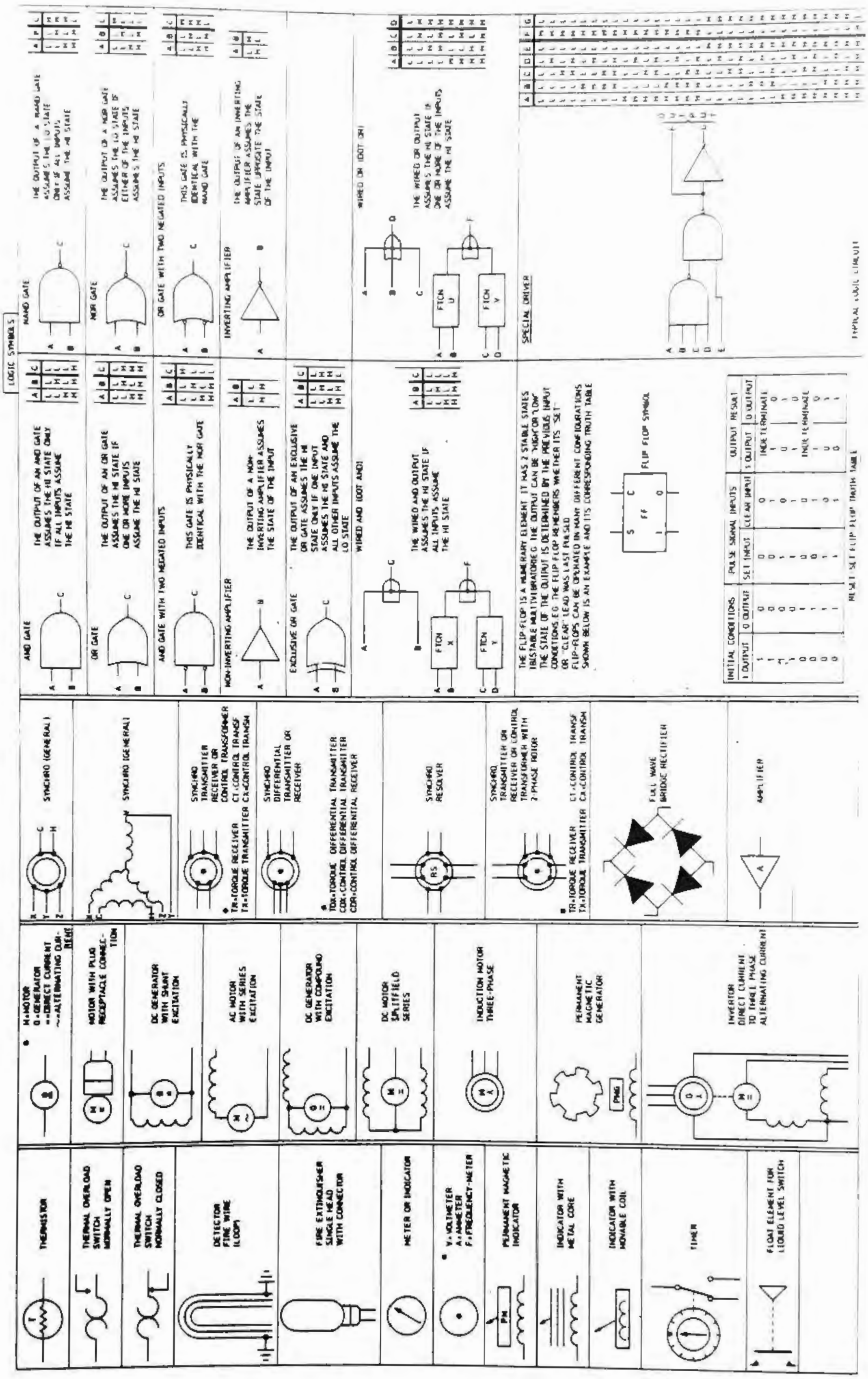
SYMBOL LIST 1

SYMBOL LIST 2



CODE 6

A/P-E



SYMBOL LIST 3

21.0 ALTERNATOR CIRCUIT

The two alternator circuits are identical. An alternator circuit comprises the following components:
- an alternator, mounted on the accessory gearbox of the engine.
- a control unit, located on the RH wall in the cargo compartment.
- an isolating transformer unit, located on the RH wall in the cargo compartment.
- a 208-V AC circuit breaker panel, located in the ceiling of the cargo compartment.

The alternator is the brushless-type, which comprises three main parts. These parts are:
- The permanent magnet generator. This generator generates a 3-phase AC voltage, which is applied to the control unit, in which it is rectified into a DC voltage. The DC voltage, thus obtained, is used for the electronics in the control unit and for excitation of the exciter generator.
- The exciter generator comprises a set of stator windings and three sets of rotor windings. The AC voltages, generated by the rotor windings, are fully dependant on the average DC excitation voltage which, in its turn, is made dependant on the alternator output voltage.
  The 3-phase AC voltage generated by the rotor windings is rectified into DC. The DC voltage is used for the rotor windings of the main generator.
- The main generator comprises a set of rotor windings and three sets of stator windings. The main generator generates a 3-phase AC voltage.

Since the alternator output voltage is depending on the load, the voltage must be adjustable. This is possible by varying the average DC excitation voltage. The voltage is controlled by the control unit, which senses the alternator output voltage via the isolating transformer unit.
In the control unit the alternator output voltage is rectified and filtered. The output is a DC voltage with a saw-tooth-shaped ripple. The output signal is compared with a reference signal.
There are three situations:
- In case the alternator output voltage is 120/208 V, then during each cycle of the output signal 50% of the time it is less than the reference and 50% it is more than the reference signal. Therefore during one cycle the comparator switches the switching regulator on during 50% of the time and 50% off. The average excitation voltage, thus obtained is just sufficient to maintain the alternator output voltage at 120/208 V.
- In case the alternator output voltage is lower than 120/208 V then the "on" time of the switching regulator is more than 50% and the "off" time less than 50%. Hence the average excitation voltage increases with respect to the previous situation and the alternator output voltage increases.
- In case the alternator output voltage is higher than 120/208 V, then the "on" time is less than 50% and the "off" time is more. The average excitation voltage therefore decreases and so does the alternator output voltage.

In this way the alternator output voltage is kept at 120 $\pm$ 2.5 V (phase voltage). The frequency of the alternator output is 400 Hz when the engine rpm is 12000 (generator rpm 8000).
The alternator can only operate when the alternator switch is in ON.
When the switch is in OFF the excitation voltage circuit is interrupted, hence the alternator output voltage drops to zero.

In case the voltage regulation part of the control unit fails the alternator voltage increases. When the voltage exceeds 135/234 V then the overvoltage detector triggers its overvoltage relay.

Contacts of the relay interrupt the excitation voltage circuit, hence the alternator output drops to zero and the consumers are protected.
The overvoltage relay remains energized due of its hold-in circuit and because it is supplied from the permanent magnet generator. Other contacts of the relay now supply a ground signal to a magnetic indicator on the maintenance, annunciator and test panel.
The indicator will change over from black to red.
The overvoltage relay can be reset by switching the alternator off and on again. The magnetic indicator can be reset to black by pressing the ANNUN RESET button on the maintenance, annunciator and test panel.

When the AC buses are supplied, the voltmeter reads the phase-neutral voltage (120 V) and the inoperative relay (located behind the 208-V AC circuit breaker panel) energizes. A contact of this relay interrupts a ground signal for the red INOP light.
When the relay de-energizes the INOP light comes on.
The red O.HEAT light comes on when the alternator temperature exceeds 190 $\pm$ 6 degrees C.

In the alternator-output supply lines there is a 3-phase circuit breaker (located in the engine accessory gearbox compartment), which protects the alternator against short circuits.
In the A-phase supply-line there is a current transformer (located behind the 208-V AC circuit breaker panel), which transforms the line current for the ammeter.

The overvoltage detector can be checked by pressing the ALTERNATOR OVERVOLTAGE test switch on the maintenance, annunciator and test panel to TEST. The result is that the alternator output voltage drops to zero, the red INOP light comes on and the magnetic indicator will change over to red.

There are test points on the maintenance, annuncitator and test panel to measure the bus voltage (A-B, B-C, C-A; 208 V, A-Y, B-Y, C-Y; 120 V).

END

22.0 INVERTER CIRCUIT

An inverter provides an AC voltage from a 28 V DC supply. It comprises an electronic generator which generates a 400-Hz signal and amplifiers necessary to amplify the 400-Hz signal to 115-V level.

The inverter circuit comprises three main inverters and one essential inverter. They are located under the cargo compartment floor.
The various relays and contactors are located in the main junction box.
The transformers, to step down the 115 V to 26 V, are also located in the main junction box.

Main electrical power for the main inverters comes from the main DC tie bus via heavy-duty circuit breakers and inverter contactors. The circuit breakers are located on the main junction box, RH side of the cockpit entrance. Control power for the inverter contactors comes from either the main DC tie bus or the main DC bus. Inverters, the contactors of which receive control power from the main DC bus are subject to load shedding.

When a main inverter is inoperative, a contact inside the inverter provides an earth signal, via pin F, for the red inoperative light.

The essential inverter is supplied from the battery bus. It comes in operation when the ESSEN PWR switch is operated.

The buses are supplied as follows:

- Main AC bus 1. This bus is normally supplied by inverter 1 when transfer contactor 1 is energized. The bus is transferred to inverter 3 when transfer contactor 1 de-energizes and transfer contactor 4 is energized. Transfer contactor energizes when the TRANSFER switch is put in position 1 and inverter 1 switch in OFF.

- 26-V main AC bus 1. This bus is supplied from the main AC bus 1 via a transformer.

- Main AC bus 2. This bus is normally supplied by inverter 2 when transfer contactor 2 is energized. The bus is transferred to inverter 3 when transfer contactor 2 de-energizes and transfer contactor 3 is energized. Transfer contactor 3 energizes when the TRANSFER switch is put in position 2 and the inverter 2 switch in OFF.

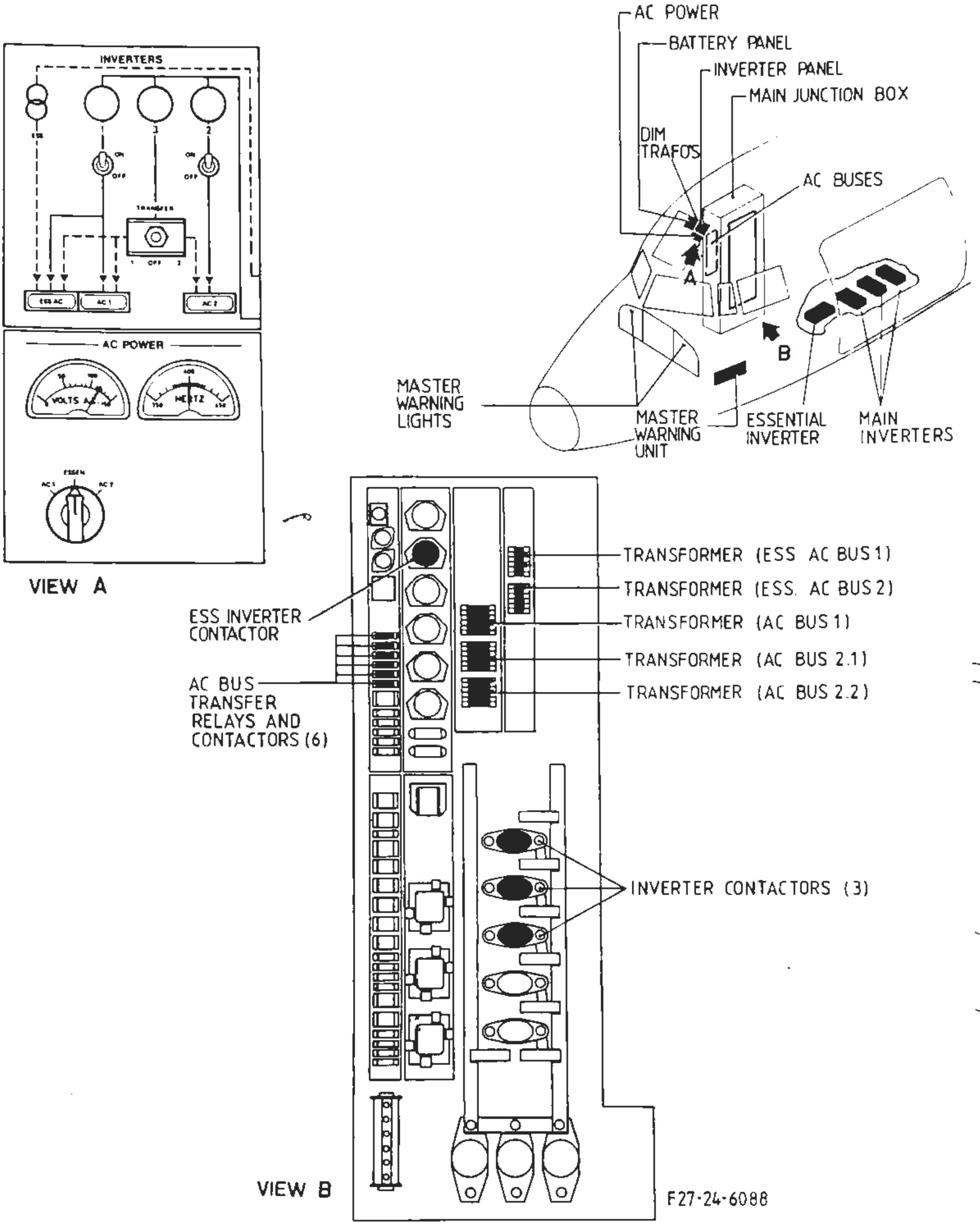
- 26-V main AC buses 2.1 and 2.2. These buses are supplied from the main AC bus 2 via transformers.

- Essential AC bus. This bus is normally supplied by inverter 1 when essential transfer relay 5 is energized and essential transfer relay 6 is de-energized. The bus is transferred to inverter 3 when both essential transfer relays 5 and 6 are de-energized, i.e. inverter 1 is switched off and inverter 3 is in operation. The bus is transferred to the essential inverter when the essential transfer relay 6 is energized. This occurs when the ESSEN PWR switch is selected up.

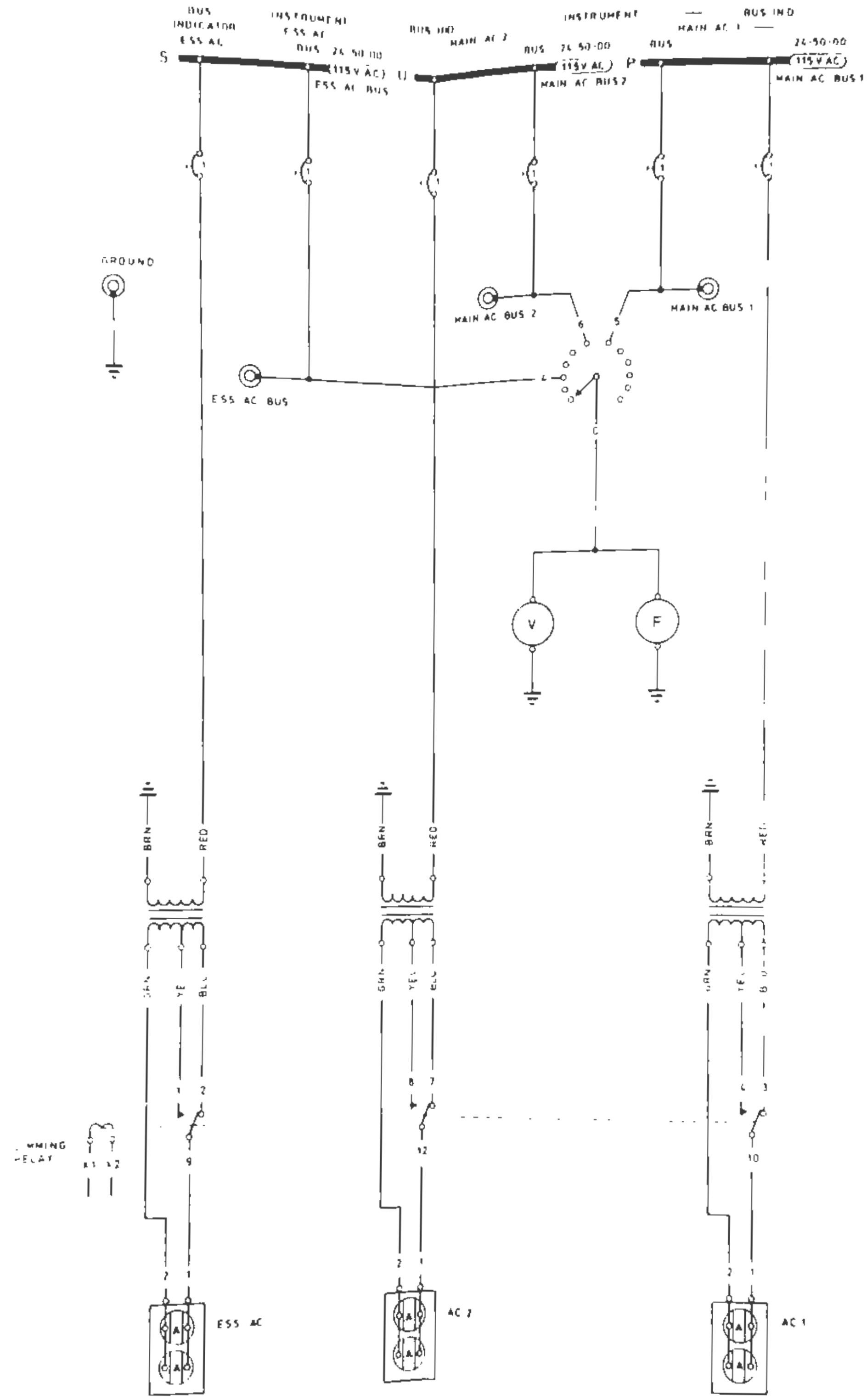
- 26-V essential AC buses 1 and 2. These buses are supplied from the essential AC bus via transformers.

Test points to check the various bus voltages are located on the maintenance, annunciator and test panel.

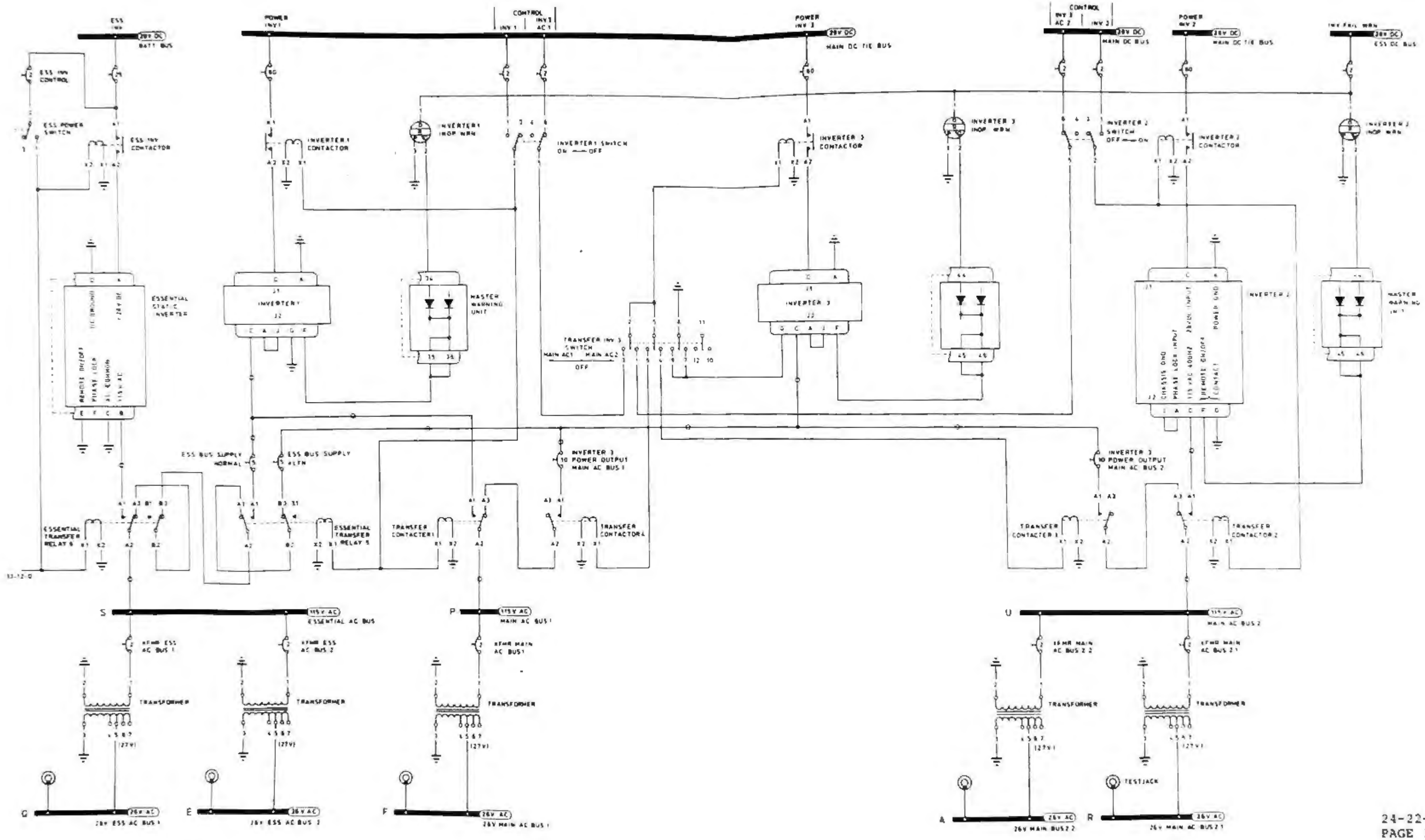
END



INVERTERS, CONTROLS AND LOCATIONS



INVERTER BUSES, INDICATION



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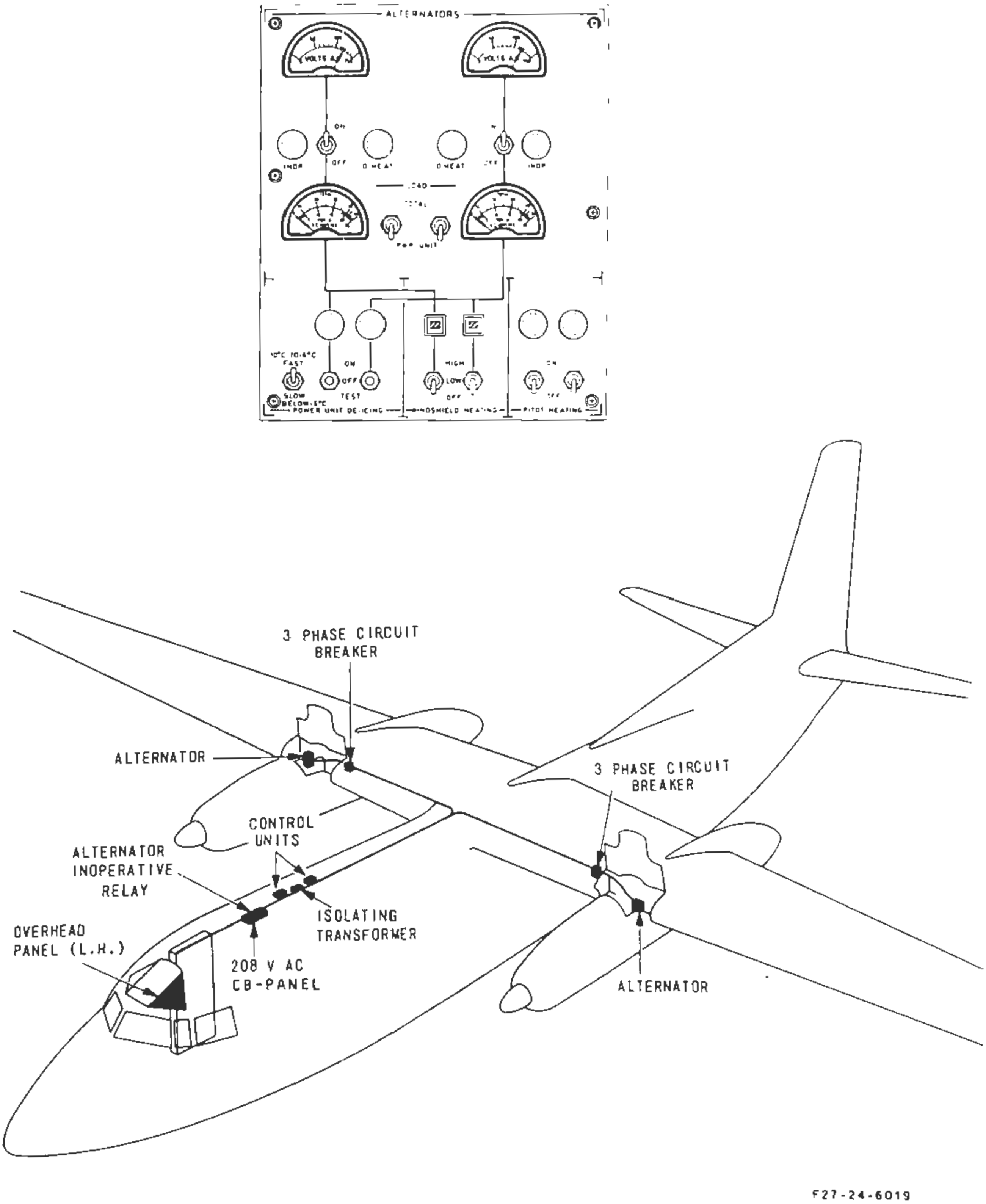
PAGE 101

INVERTER POWER DISTRIBUTION



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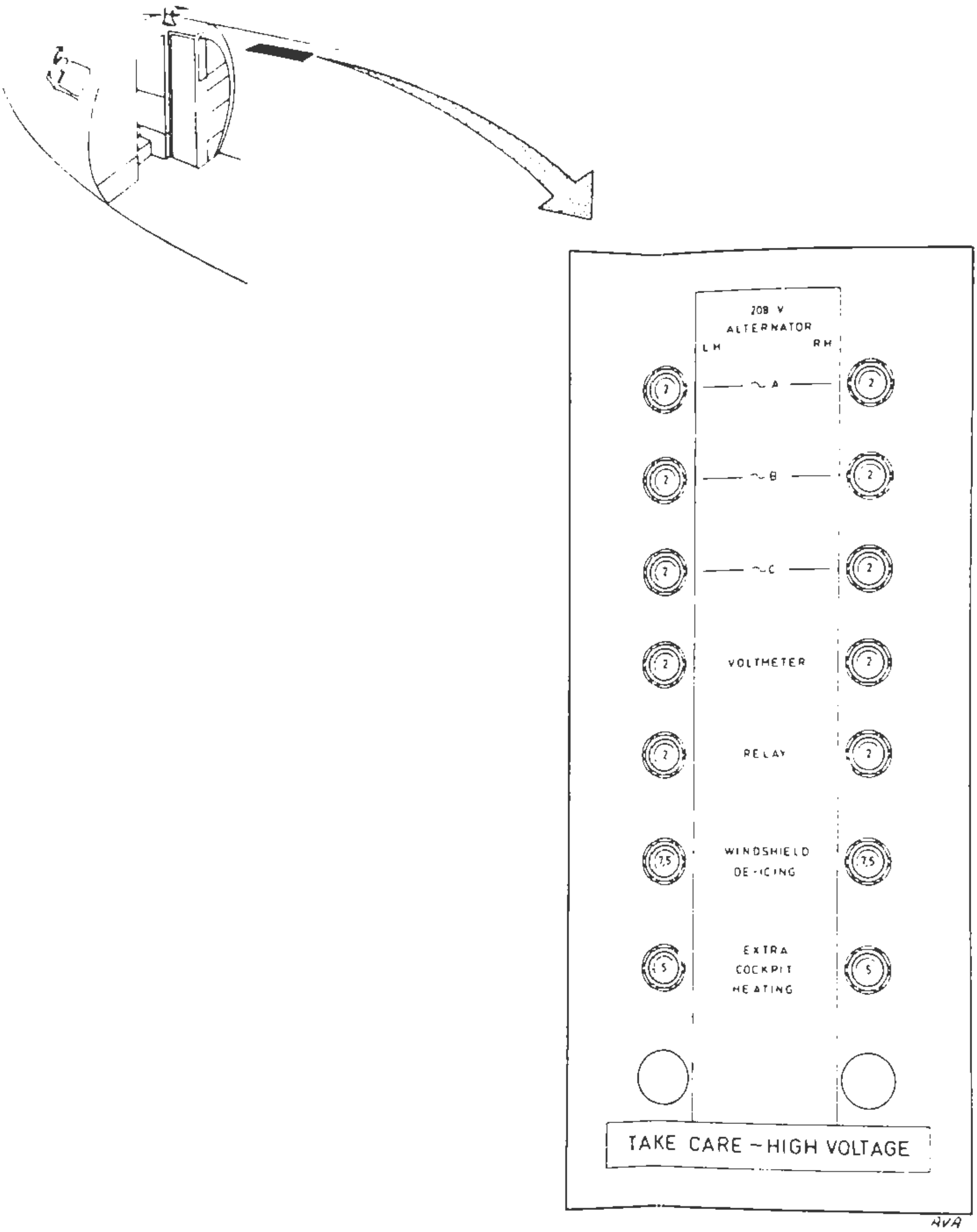
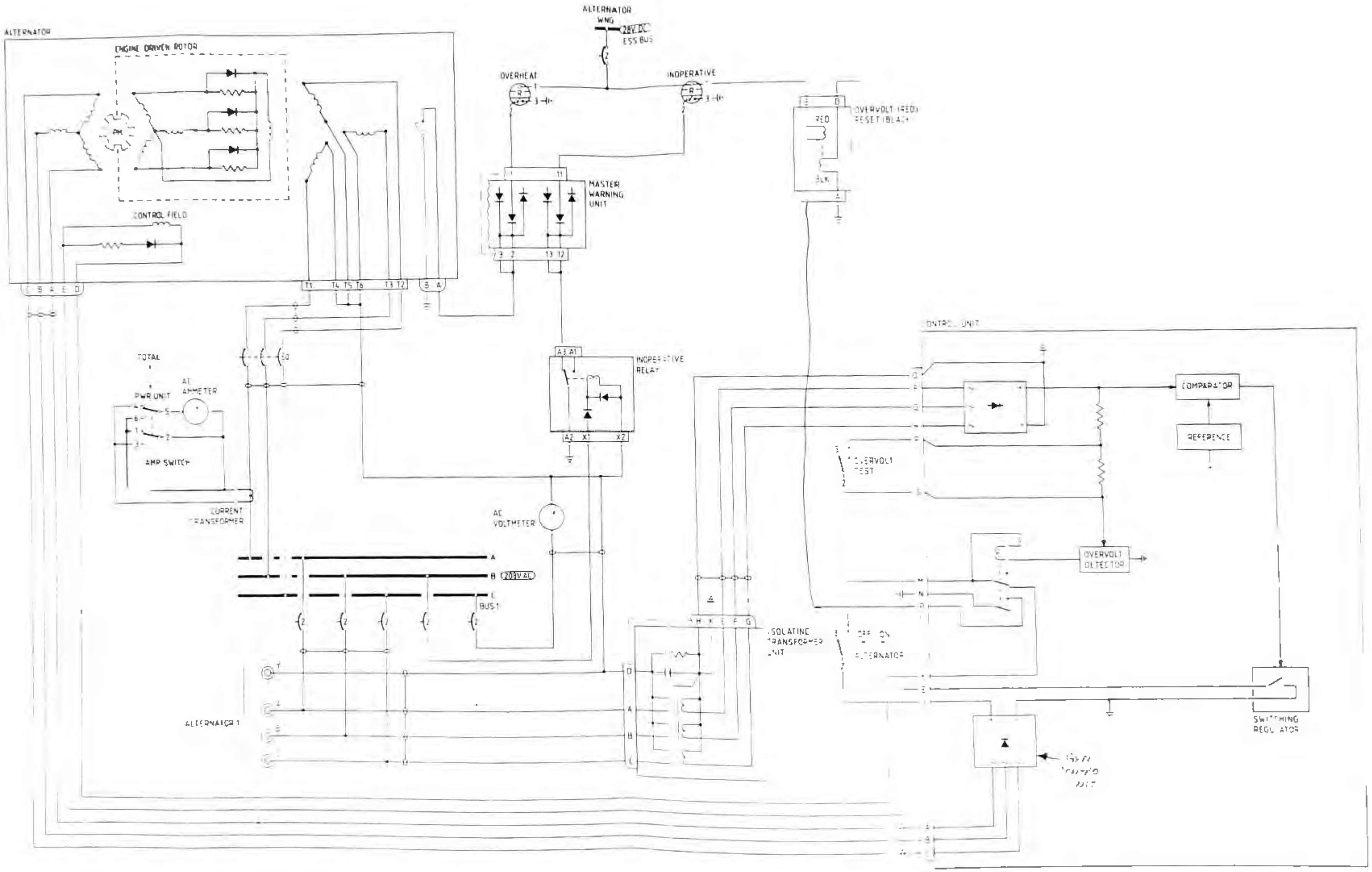
ALTERNATORS, CONTROLS AND LOCATIONS



208 V CB-PANEL



ALTERNATOR CIRCUIT

30.0/40.0 DC POWER CIRCUIT

The DC power circuit comprises the following components:
- two engine-driven generators, one mounted on each accessory gearbox.
- for each generator a control unit, located in the radiorack, top shelf.
- two batteries located in the nose wheel bay.
- for each battery a contactor, mounted on the forward pressure bulkhead, cockpit side.
- a receptacle on the RH side of the nose section, to connect a 28-V DC ground power unit (external power).
- various relays and contactors in the main junction box.

There are test points on the maintenance, annunciator and test panel to check generator and battery voltages.

Battery Circuit

Two 24-V, 40-Ah nickel-cadmium batteries are always connected via 80-Amp circuit breakers and isolating diodes to the battery bus. The circuit breakers are installed on the forward pressure bulkhead, cockpit side.
The diodes are located in the main junction box. They isolate one battery from another in case one battery has a lower voltage than the other.
When the DC power switch is in BATT and the batteries are sufficiently charged, the battery contactors energize and via their contacts the batteries are connected to the main DC tie bus. In the battery feeder cables, between contactor and main DC tie bus, there is a reverse current circuit breaker which trips when there is a short circuit in the battery feeder-cable thus isolating the main DC tie bus from the short circuit. The circuit breaker trips when the reverse current; current in the direction of the battery; exceeds 450 Amps. When a reverse current circuit breaker is tripped, its auxiliary contacts are open and therefore the associated battery contactor de-energizes thus the battery is also isolated from the short circuit.
The red O.HEAT light comes on in case the battery temperature exceeds 71 degrees C. With the associated red-guarded battery isolate switch the battery contactor can now be de-energized, hence that battery is disconnected from the main DC tie bus.
Ammeters on the BATTERY MONITORING panel indicate the battery charge (positive) or the battery discharge (negative) current.

The batteries are installed in boxes and are secured in position by rod-and-lug clamps. Retaining straps are provided for the electrical cables which are connected by a heavy-duty, quick-release, double-pole connector.
A box ventilation system is provided to prevent the accumulation of gases which are given off during in-flight charging.
The ventilation system consists of a suction-air circuit and a pressure-air circuit. The pressure differential is created by an air-scoop which has two openings, one exposed to the airstream, the other one shielded from the airrtream.

WARNING: BATTERY ELECTROLYTE WILL BURN SKIN AND CLOTHING. IF SPILLED, NEUTRALIZE WITH A 3% SOLUTION OF ACETIC ACID, VINEGAR, LEMON JUICE OR A 10% SOLUTION OF BORIC ACID, OR, IF THESE ITEMS ARE NOT AVAILABLE, WASH THOROUGHLY WITH WATER. SEEK MEDICAL ATTENTION IMMEDIATELY IF ELECTROLYTE COMES IN CONTACT WITH EYES.

External Power Circuit

When the aircraft is on the ground a 28-V ground power unit can be connected to the aircraft. As soon as external power is plugged in the white EXT PWR light is on. The ground service bus transfer contactor energizes and the ground service buses 1 and 2 are supplied.
When the DC power switch is in EXT PWR, the external power contactor energizes and the ground power unit supplies the main DC tie bus.

NOTE: Before selecting EXT PWR, the DC voltmeter must be used to verify that the voltage of the ground power unit is 28 V (the rotary DC selector switch must be in EXT PWR).

In case both battery reverse current circuit breakers are tripped, then the external power contactor cannot be energized, hence external power cannot supply the main DC tie bus.

DC Generator Circuit

The engine-driven generators generate 28 V as soon as the engine is running.
The generator output voltage depends on the load and the engine rpm. A voltage regulator, part of the generator control unit varies the excitation voltage of the generator such that in case the output voltage drops there is a higher excitation voltage and in case the output voltage rises there is a lower excitation voltage. The result is that the output voltage is 28 $\pm$ 2.5 V independant from load and rpm.
The generator can deliver 375 Amps continuously, while 400 Amps maximum is allowed for 30 minutes.
The generator control unit also controls the generator bus contactor which, provided it is energized, connects the generator output to the main DC tie bus.
The conditions to energize are:
- the associated generator switch is in ON.
- the generator voltage is initially 0.5 V higher than the voltage on the main DC tie bus. This is checked by the comparator in the generator control unit.
- the generator voltage is at least 22 V. This is also checked by the comparator.

The generator bus contactor de-energizes when:
- the generator switch is in OFF or
- the generator voltage drops due to engine shut-down, this is also sensed in the comparator unit (no further details).

In case the voltage regulator fails the generator output voltage could increase. In case the voltage exceeds 30 V an overvoltage detector activates a latch-type overvoltage relay (the detector and relay are located in the generator control unit).

Contacts of the overvoltage relay interrupt the excitation voltage for the generator and therefore the generator output voltage drops to zero. In case a short circuit develops between generator and main DC tie bus, the high current (450 Amps and higher) from the main DC tie bus towards the short circuit causes a reverse current circuit breaker to trip, thereby isolating the main DC tie bus from the short circuit.

Parallel to the generator bus contactor there is a generator inoperative relay which, provided it is de-energized, supplies a ground signal to the amber INOPERATIVE light.

NOTE: When both generators are inoperative, both amber INOPERATIVE lights are on and also the red INOPERATIVE BOTH light.

When the temperature in the generator housing exceeds 180 degrees C the red O. HEAT light comes on.

On the generator control unit there is an overvoltage test switch. When pressed the generator voltage drops to zero. The latch-type overvoltage relay can be reset by another switch on the generator control unit.

DC Power Distribution

The generators normally supply all buses in flight. In case of a failure some buses are automatically shedded. In case of an emergency the batteries can supply a limited number of consumers for at least 30 minutes.

There are the following buses:

- Main DC tie bus. This bus is supplied by the generators and either external power or the batteries. When the bus is supplied the LH MAIN DC bus indicator is on.

- Main DC bus. This bus is supplied from the main DC tie bus when the main DC tie bus contactor is energized. The contactor is energized when the main DC tie bus is supplied by:
  - one or two generators (generator inoperative relays 1 or 2) or
  - external power external power slave relay).

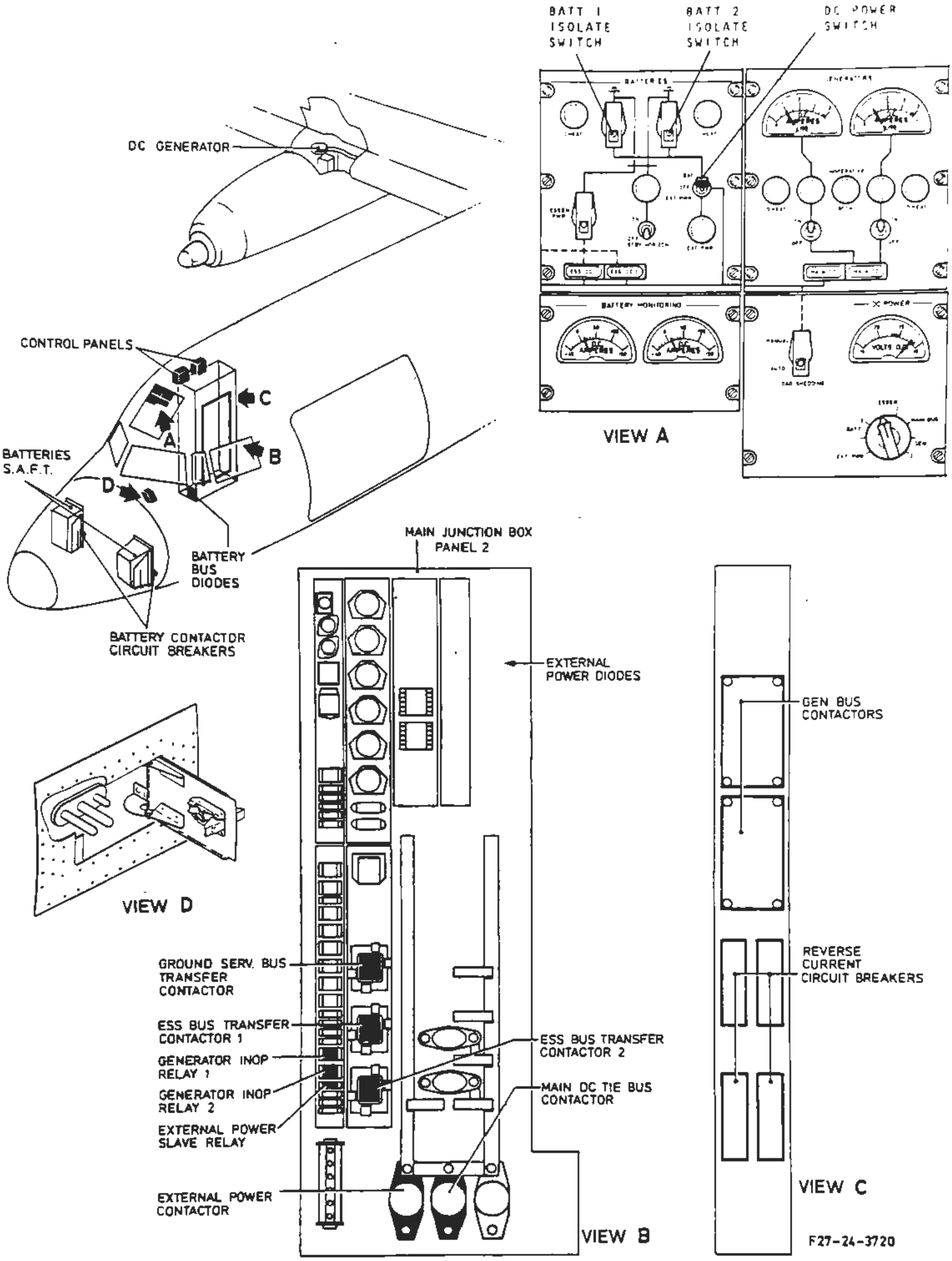
  When the main DC tie bus is supplied by the batteries, the main DC bus can also be supplied, provided the LOADSHEDDING switch is in MANUAL. When the main DC tie bus is supplied the RH MAIN DC bus indicator is on. Bus voltage can be read on the DC voltmeter when the DC selector switch is in the MAIN BUS position.

- Ground service bus 1. This bus is normally supplied from the main DC tie bus. When external power is available the bus is transferred to external power by the ground-service bus-transfer contactor.

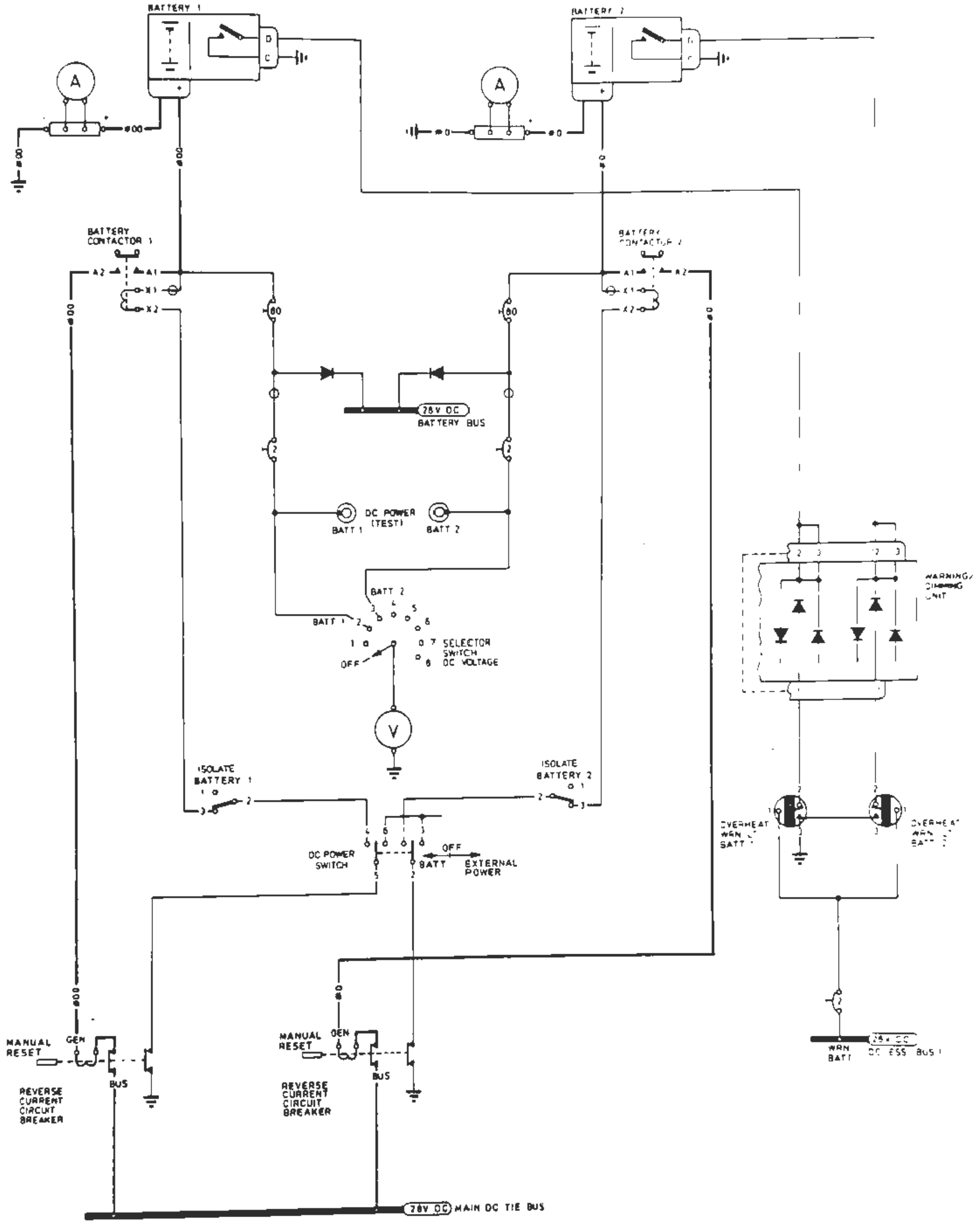
- Ground service bus 2. This bus is normally supplied from the main DC bus. When external power is available, the bus is transferred to external power by the ground-service bus-transfer contactor.

- Battery bus. This bus is always supplied by the batteries.
- Essential DC buses 1 and 2. These buses are normally supplied from the main DC tie bus. When the ESSEN PWR switch is operated the buses are transferred to the battery bus by the essential bus transfer contactors 1 and 2.
  When the buses are supplied the ESS DC 1 and ESS DC 2 bus indicators are on.
- Cabin bus 1. This bus is supplied from the ground service bus 2.
- Cabin bus 2. This bus is supplied from the main DC bus.
- Avionics essential buses 1 and 2. These buses are normally supplied from the main DC tie bus, provided MASTER RADIO switch 1 is in ON, as far as it concerns bus 1 and provided MASTER RADIO switch 1 or 2 is in ON for bus 2.
  Both buses are transferred to the battery bus when the ESSEN PWR switch is operated.
- Fuelling bus. This bus is normally supplied from ground service bus 1, provided the POWER switch on the fuelling control panel is in ON. When the ground service bus 1 is not supplied the fuelling bus is transferred to the battery bus.

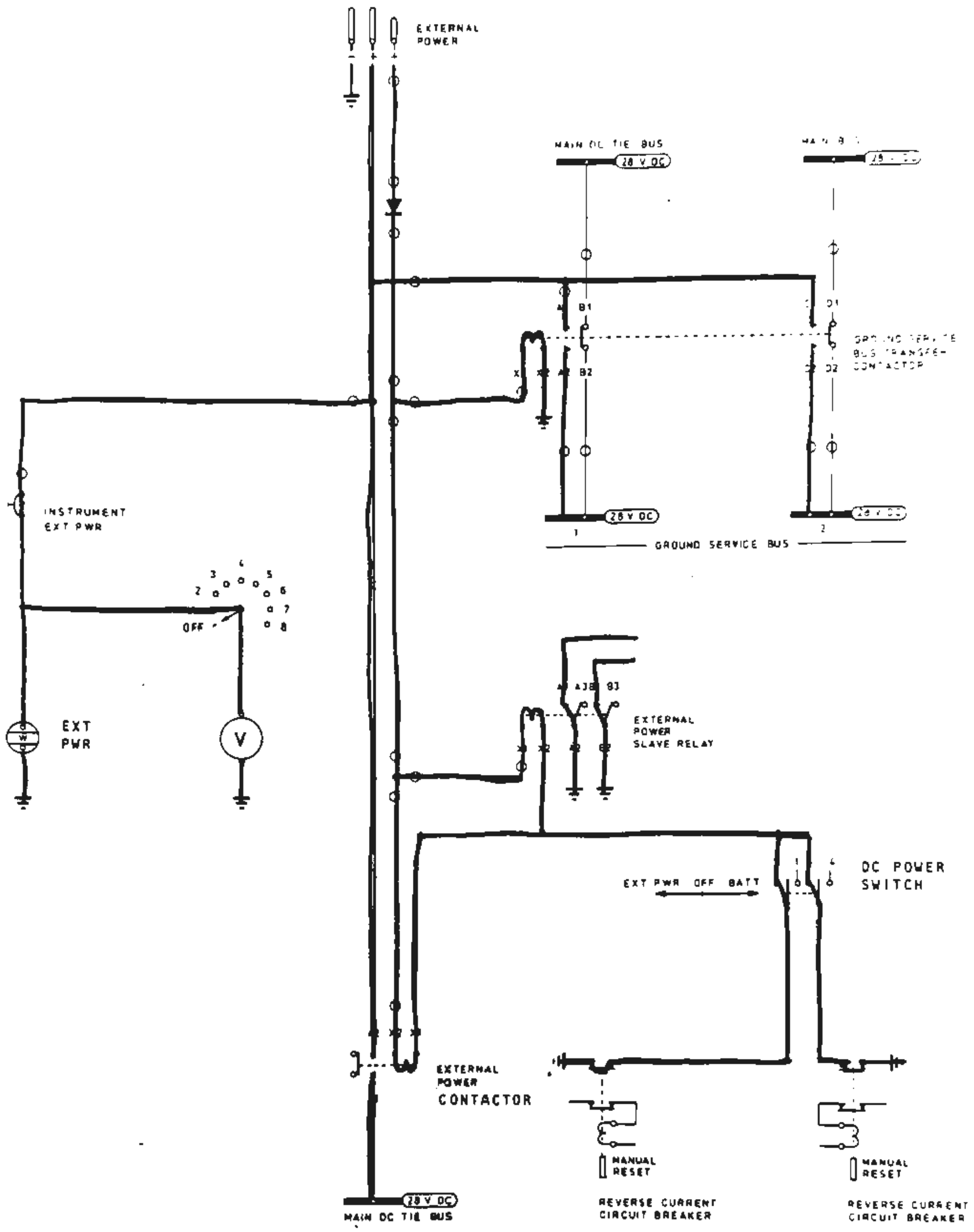
END



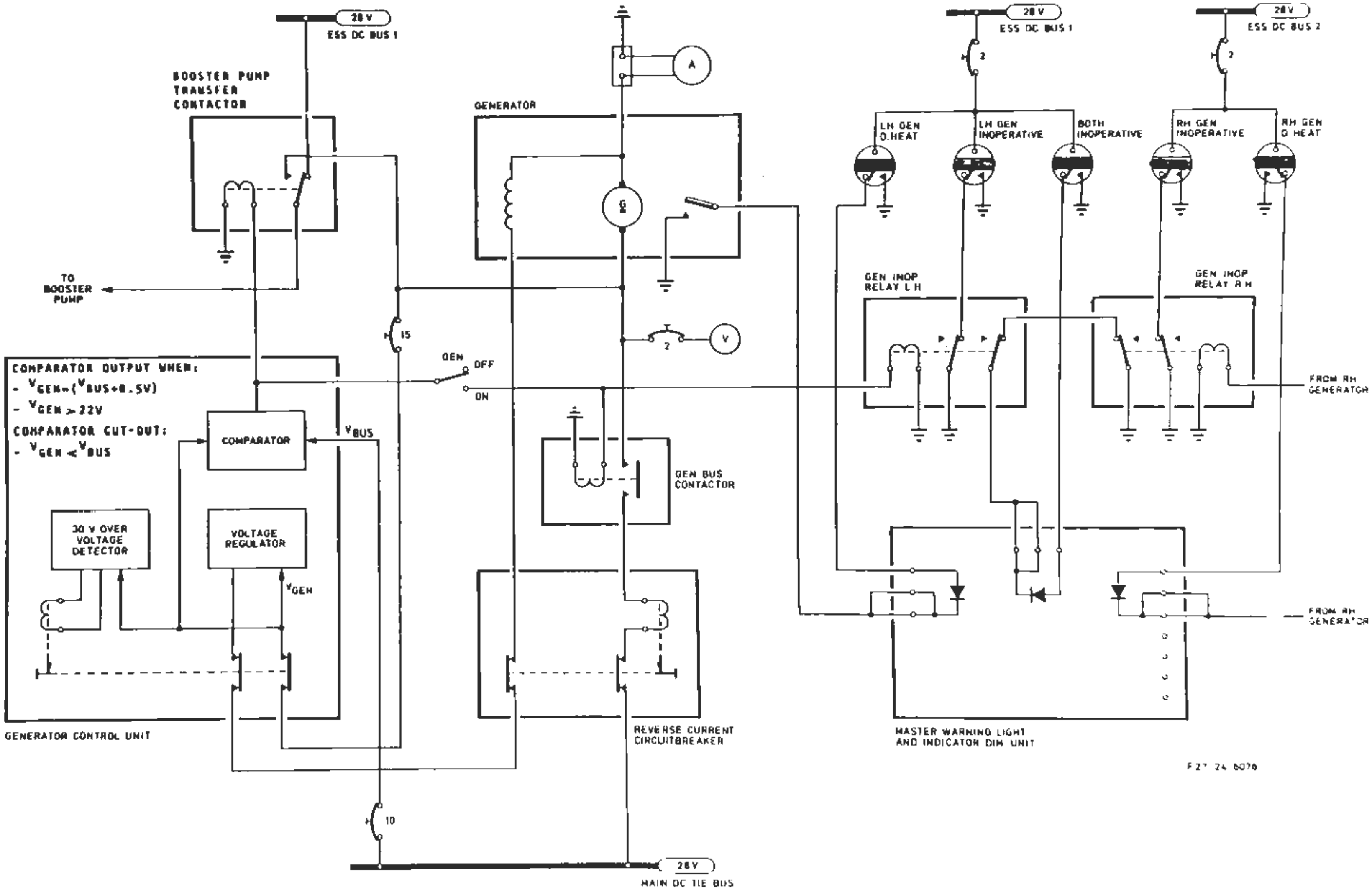
DC POWER - CONTROLS AND LOCATIONS



BATTERY CIRCUIT

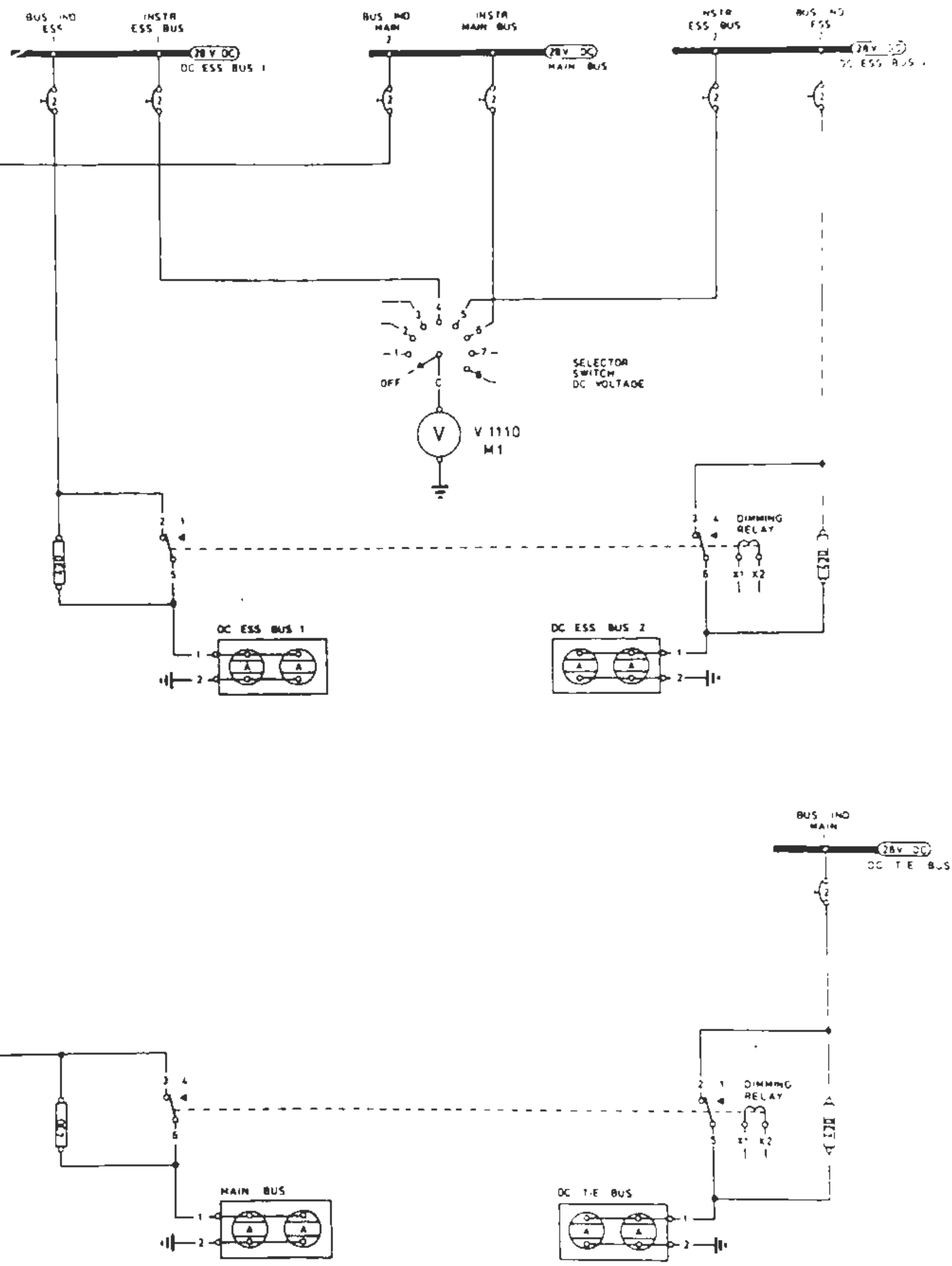


EXTERNAL POWER CIRCUIT

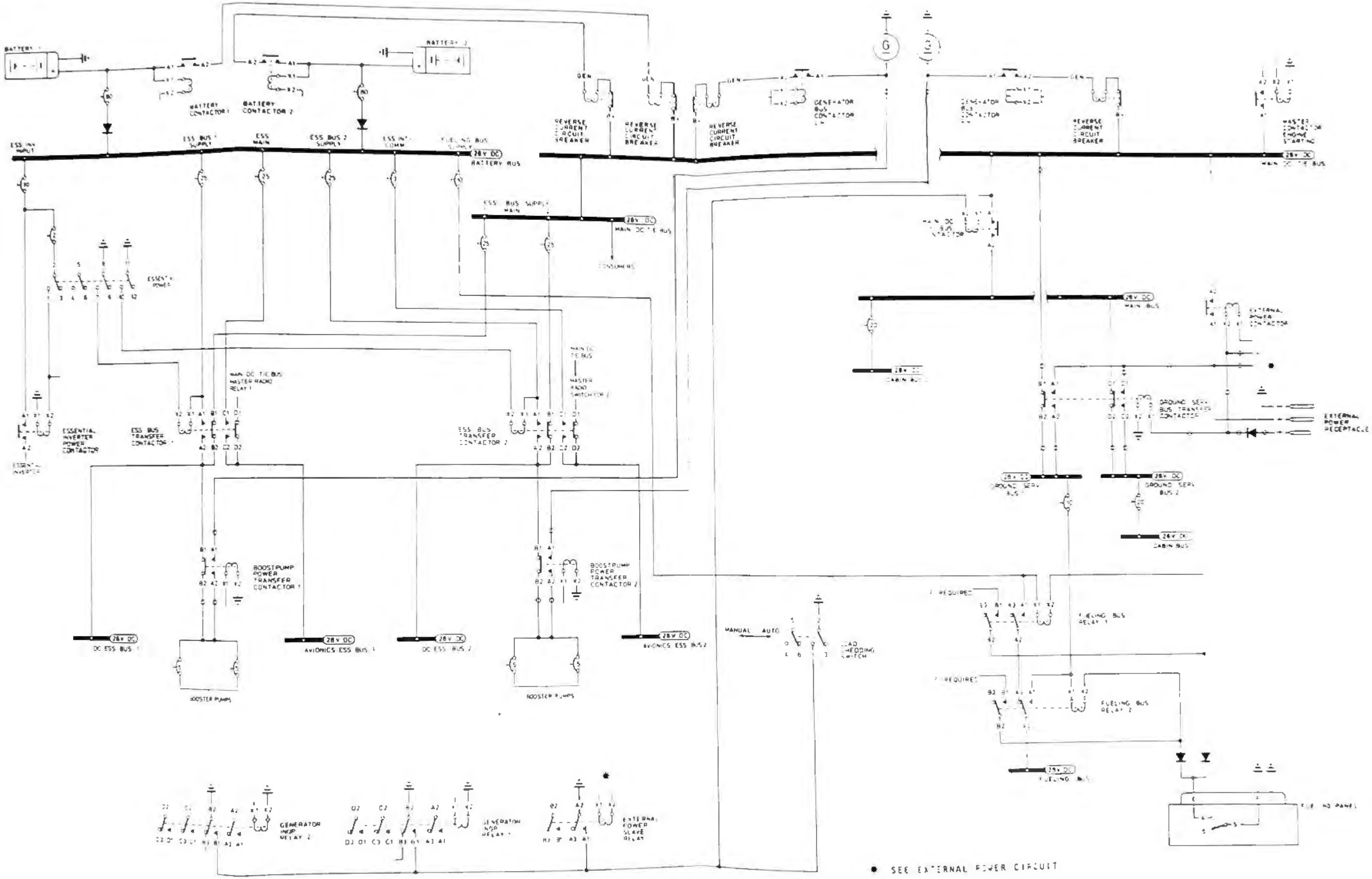


DC GENERATOR CIRCUIT

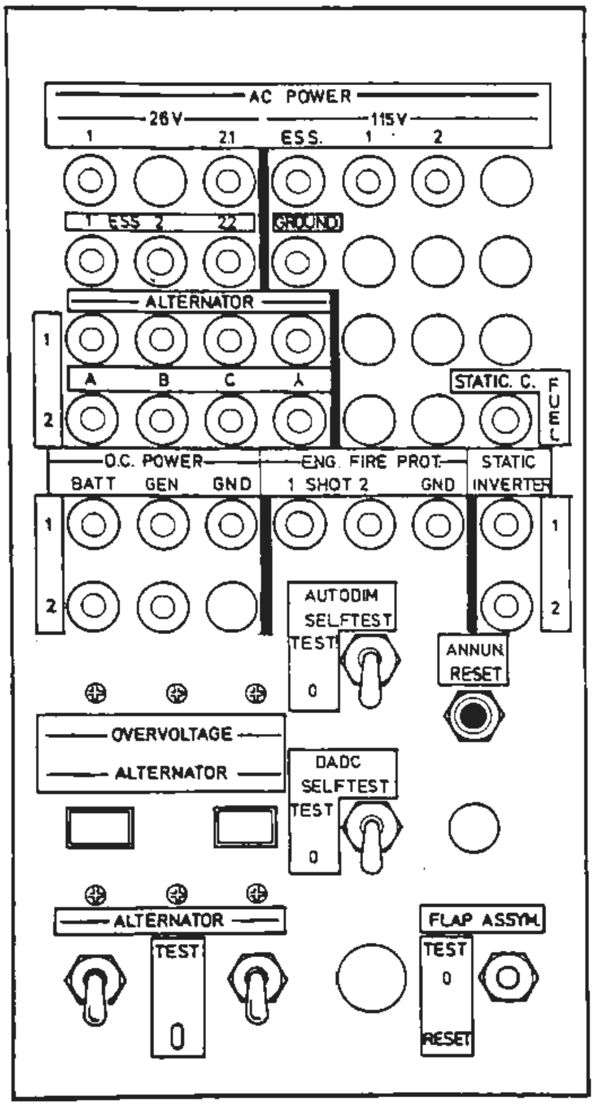
CODE 6



DC BUSES, INDICATION



DC POWER DISTRIBUTION



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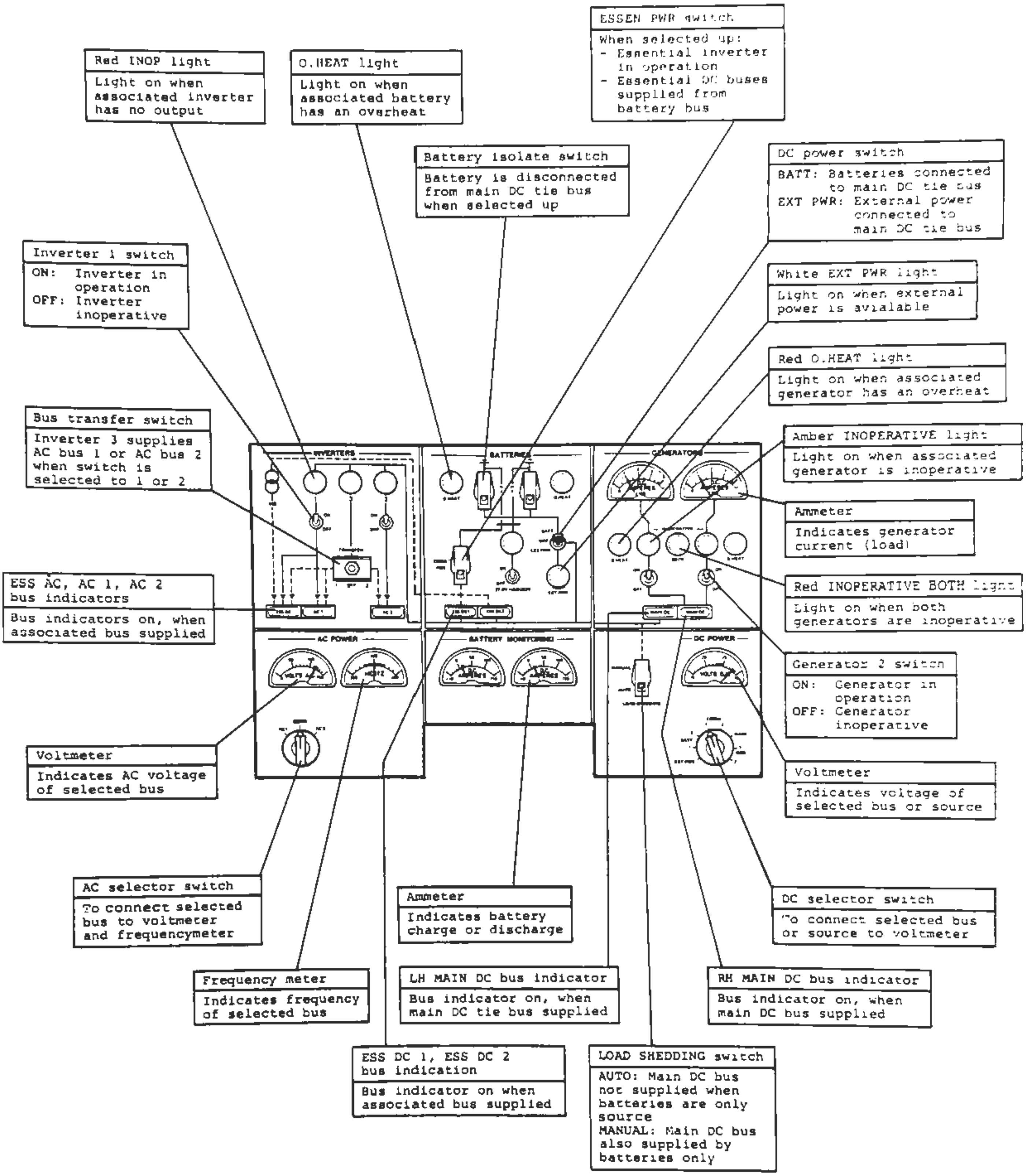
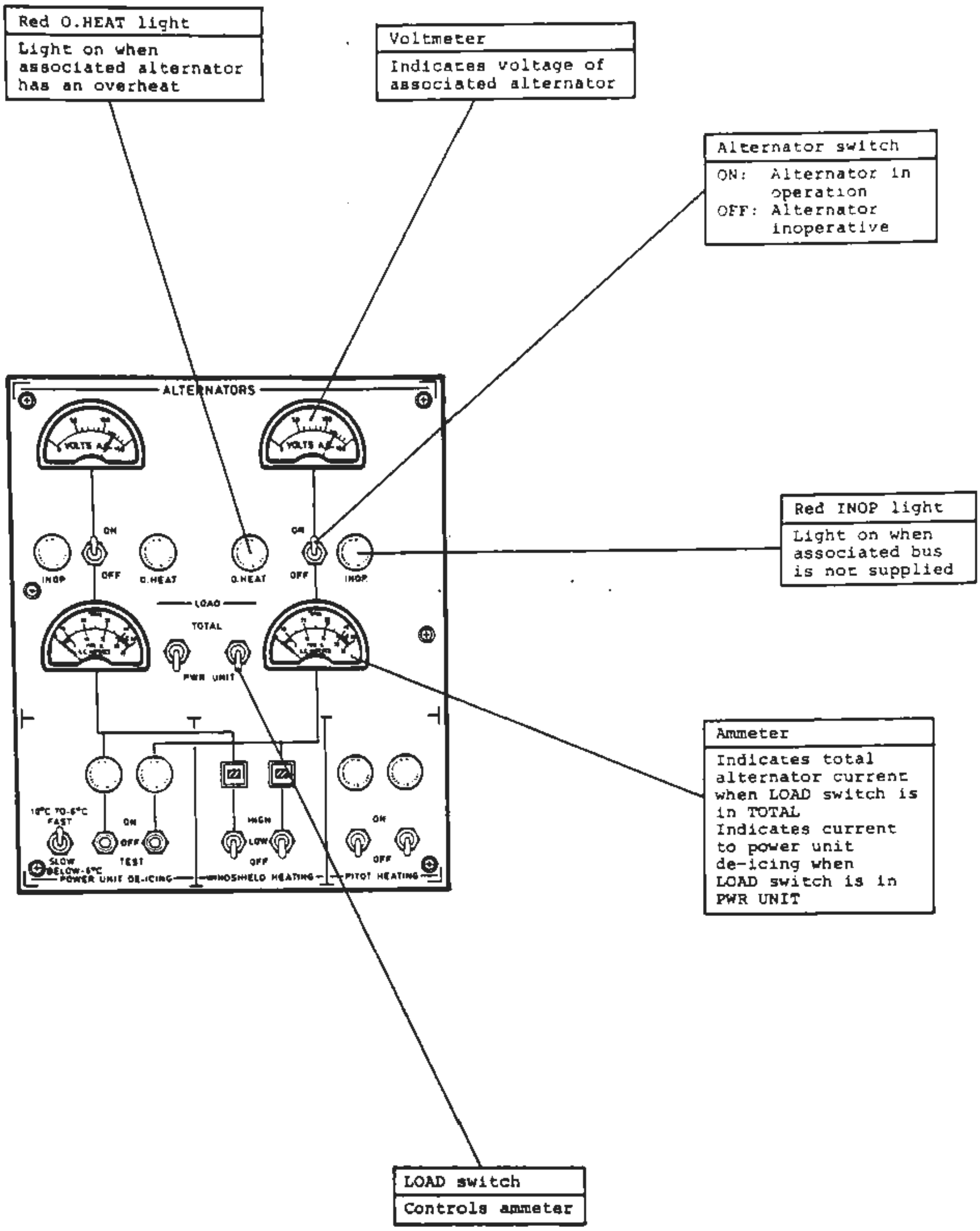
Located main J-Box in Cargo Comp

MAY OR MAY NOT HAVE

MAINTENANCE, ANNUNCIATOR AND TEST PANEL



CONTROLS AND INDICATIONS - SUMMARY 1



CONTROLS AND INDICATIONS - SUMMARY 2

25 EQUIPMENT/FURNISHING

25. EQUIPMENT/FURNISHINGS

25. EQUIPMENT/FURNISHINGS

00. GENERAL

The interior of the fuselage between the pressure bulkheads at Sta. 1400 and Sta. 16660 is divided into six compartments; being from the front to the rear: the cockpit, cargo compartment, passenger compartment (cabin), toilet compartment, main entrance compartment and luggage compartment. The cockpit is separated from the cargo compartment by a metal bulkhead at Sta. 3100, while partition walls with doors or curtains separate the other compartments.

10.0 COCKPIT

The cockpit is located between the bulkheads at Sta. 1400 and Sta. 3100 and can be entered from the cargo compartment via a step in the entrance opening. A pilot and co-pilot seat are installed on tracks on the floor structure. By removing the four attachment hooks (eight bolts) a seat can be removed from the track.

The seats have the following adjustments: vertical, fore and aft, sideways, recline, inertia reel lock and arm rest. The seats are identical in description and operation with the exception of the adjustment levers which are reversed.

A seat for a 3rd crewmember can be erected in the cockpit entrance. When the seat is not in use it can be folded; in this position the bottom of the frame is at the same level as the step between cargo compartment and cockpit. In the upright position, the seat is locked by means of two pins engaging with locking brackets on the posts of the bulkhead. The locking pins are connected to push-pull rods, operated by a lever at the front of the seat. This lever is provided with a spring-loaded knob, which must be pulled out before the mechanism can be operated, thus preventing inadvertent operation when the seat is occupied.

The pedestal is located in the centre of the cockpit and in front of this is the main instrument panel and glareshield panel. In the roof of the cockpit are located the overhead panels for various systems, whilst side panels and vertical panels on which various controls and indicators are situated, are located outboard of both pilot seats. The main circuit-breaker panel is located, behind the co-pilot's seat, on the electrical system main junction box.

20.0 PASSENGER COMPARTMENT

The F27 Mk 600 has a 44-passenger seating arrangement, 11 four-abreast rows. The cabin partition wall can be moved to the rear with a consequent increase in space of the cargo compartment.

The double seats consist of an upholstered tubular frame with a seat cushion and an adjustable backrest. The passenger seats are attached to rails running along the length of the cabin. The seats will be adjustable in increments of one inch. This feature will keep conversion times to a minimum. The backrest adjustment lever is located on the left-hand arm rest.

Seat belts with quick-release type buckles are mounted to the seat frame and stowage bags for life vests are provided at the underside of each seat.

Luggage bins are located over the LH and RH row of passengers seats. The bins are hinged and locked between the passenger service panels and the ceiling. Operation of the lever in the centre upper part of the bin will disengage the locking latches from catch hooks via rods. A snubber at the LH side prevents the bin from falling open.

30.0 PANTRY

The pantry unit, located in the cargo compartment, is basically a self-contained assembly that is secured to the cargo floor by means of four bolts or by means of locking devices on rails.

40.0 TOILET COMPARTMENT

The toilet compartment is located opposite the passenger door, it is separated from the main entrance compartment by partition walls and can be entered via a folding door. The emergency exit door is located in this compartment. A wash-stand and a flushing type toilet assembly are provided.

50.1 CARGO COMPARTMENT

The cargo compartment is located between the cockpit and the cabin partition wall. The front part of the compartment is taken up by the pneumatic compartment on the left-hand side and by the main junction box and radio rack on the right-hand side. The right-hand side and rear portion of the compartment is used as a cargo stowage space.

50.2 LUGGAGE COMPARTMENT

The luggage compartment is located between the toilet compartment wall and the rear pressure bulkhead (Sta. 16660) and is used as an additional cargo stowage space. This compartment is divided horizontally into two spaces by means of a removable shelf with nylon freight netting in front. Opposite the passenger door against the toilet compartment wall a folded stewardess seat is located; the locking mechanism is manually controllable by an operating lever.

60.0 EMERGENCY EQUIPMENT

Various items for use in case of emergency are located throughout the aircraft.

A. Axe. An axe is mounted at a vertical wall of the cockpit entrance LH side.

B. Wing-flap emergency drive-crank handle. This handle, used to operate the flaps when electrical operation fails, is stowed in a LH hat-rack luggage bin under the centre wing.

C. Life vests. Provisions are made in the cockpit for life vest stowage while for the passengers the life vests can be stowed under the passenger seats.

D. Emergency/night lights. Small lights are located close to the crew/cargo door, passenger door, toilet compartment, the cabin emergency exit windows, and at various positions in the passenger compartment.
These lights are normally on during flight.

E. Evacuation lights. Evacuation lights are located in the same light assemblies as the emergency/night lights. However, the evacuation lights are normally out during flight but can illuminate because of their own batteries.

F. Portable oxygen bottle. A portable oxygen bottle with full face mask is attached to the structure of the pilot's seat.

G. First aid kits. Two first aid kits are provided, one located in the cockpit, and one located in a LH hat-rack luggage bin under the centre wing.

H. Portable fire extinguishers. A CO2 extinguisher is located at the cockpit bulkhead behind the pilot's seat.
Two water extinguishers are located in the passenger cabin; one in a RH hat-rack luggage bin and one clamped on the rear cabin bulkhead.

I. Escape rope for cockpit crew. An escape rope is stowed in a small box above the RH sliding window.

70.0 MISCELLANEOUS

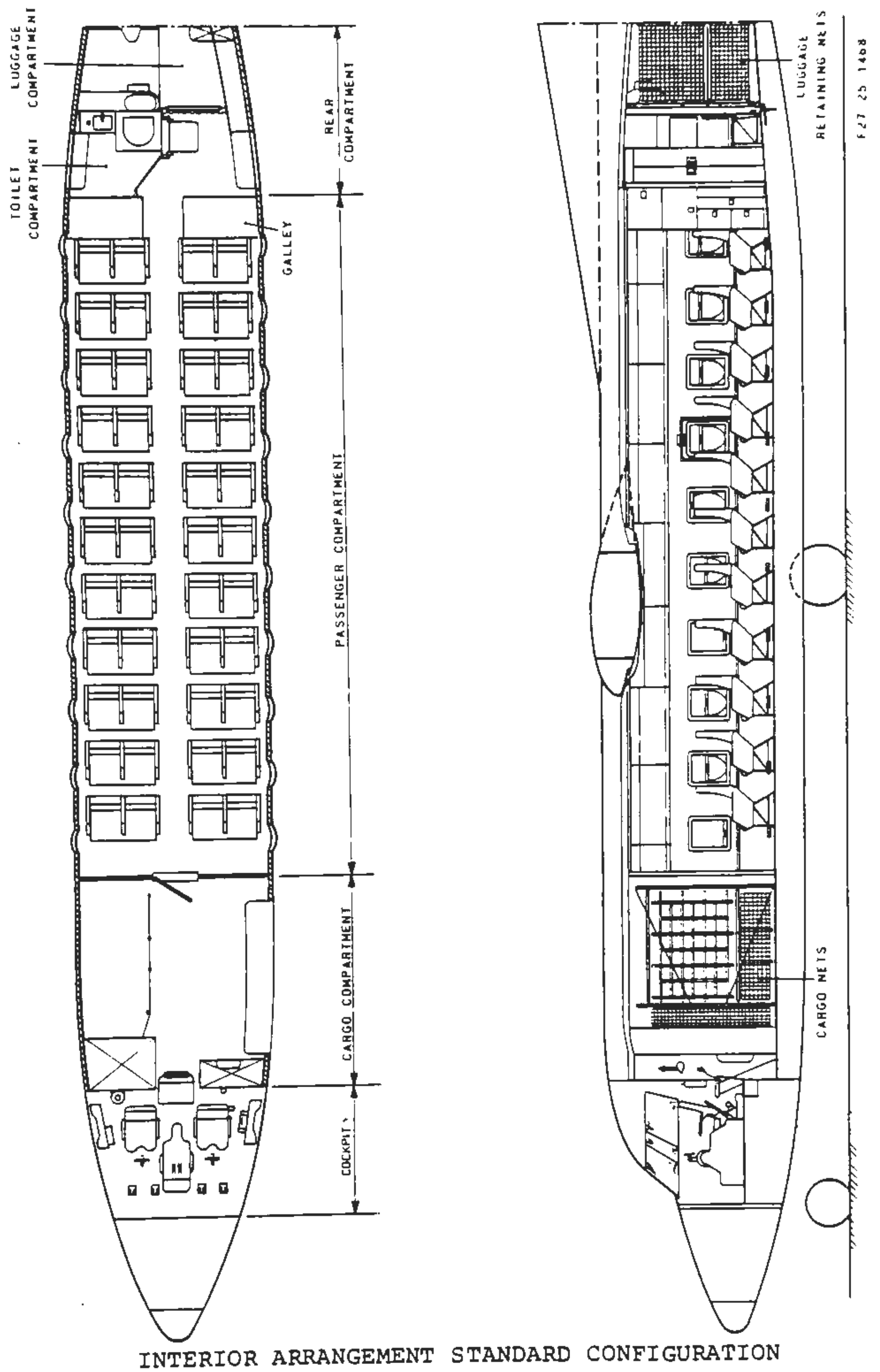
70.1 Soundproofing and Thermal Insulation

To keep the noise level and the loss of heat in the aircraft to a minimum, soundproofing material is attached to the fuselage structure between the two pressure bulkheads. In general the soundproofing consists of outer and inner blankets. The outer blankets against the fuselage skin consist of two layers of fibreglass, sandwiched between two vinyl films and a layer of cheese cloth, and are attached to the stringers with wire hooks. The inner blankets, behind the vinylized fabric upholstery, are of the same type as the outer blankets but the vinyl film side is facing inboard, whereas the vinyl film of the outer blanket faces the aircraft structure.

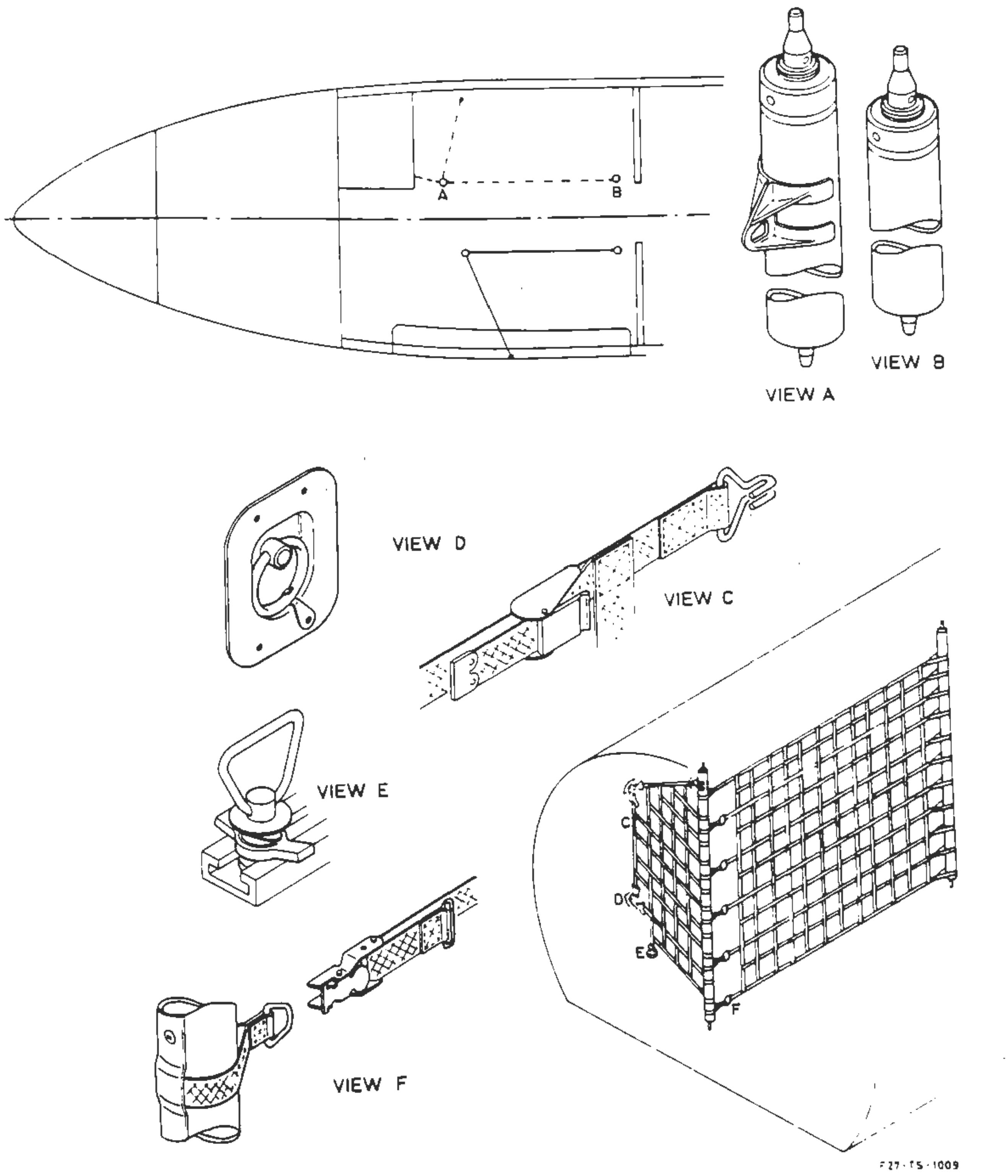
70.2 Upholstery

The upholstery of the cargo and luggage compartments consists of plastic sheeting. Plastic sheeting is also provided on all doors and door jambs. The toilet compartment is covered with vinylized fabrics. The upholstery is bonded, stapled or screwed to the structure.
The passenger compartment interior trim consists of wainscoting, sidewall panels, overhead luggage bins and ceiling panels. The floor of the cabin is covered with carpets, attached by fasteners and adhesive tape.

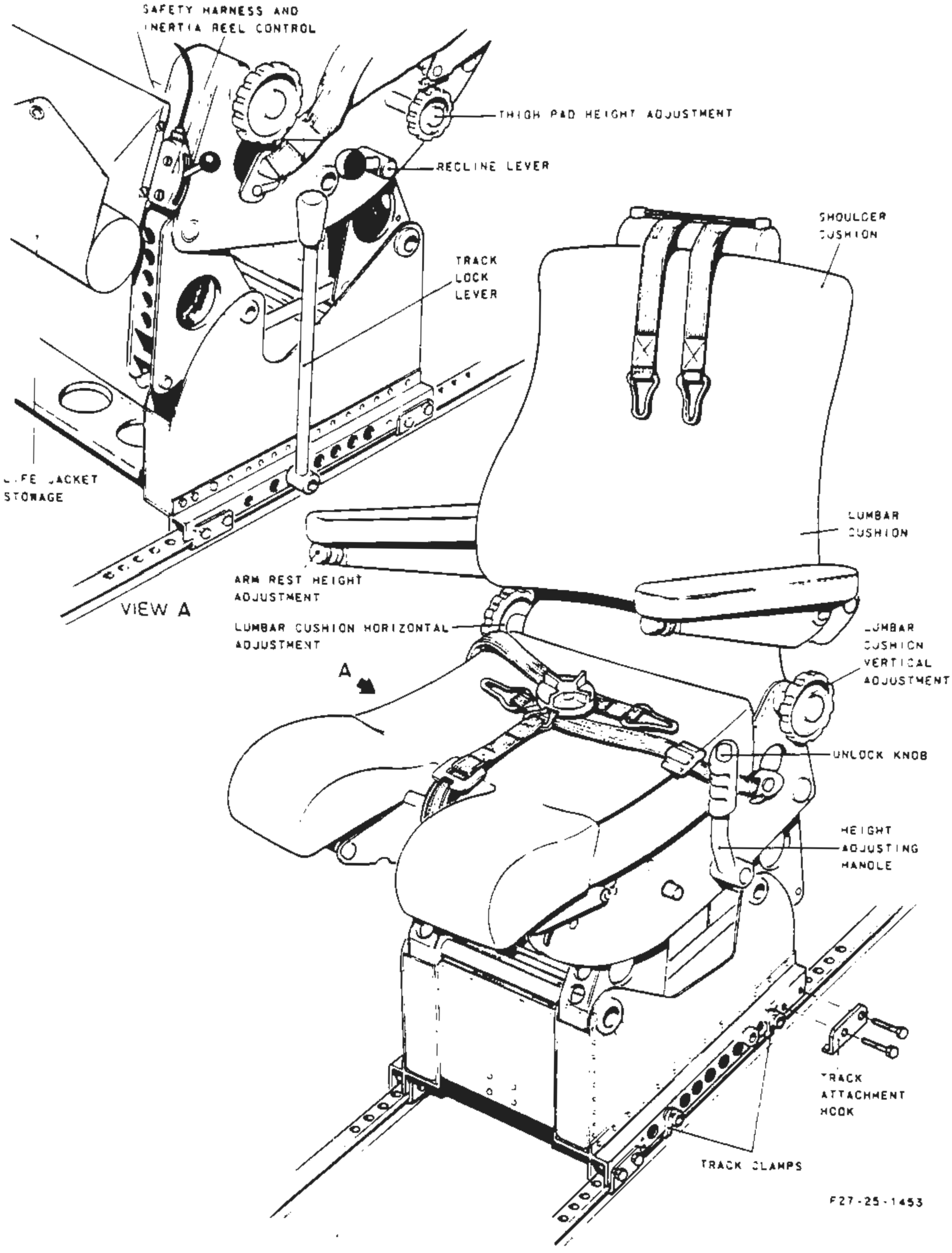
END



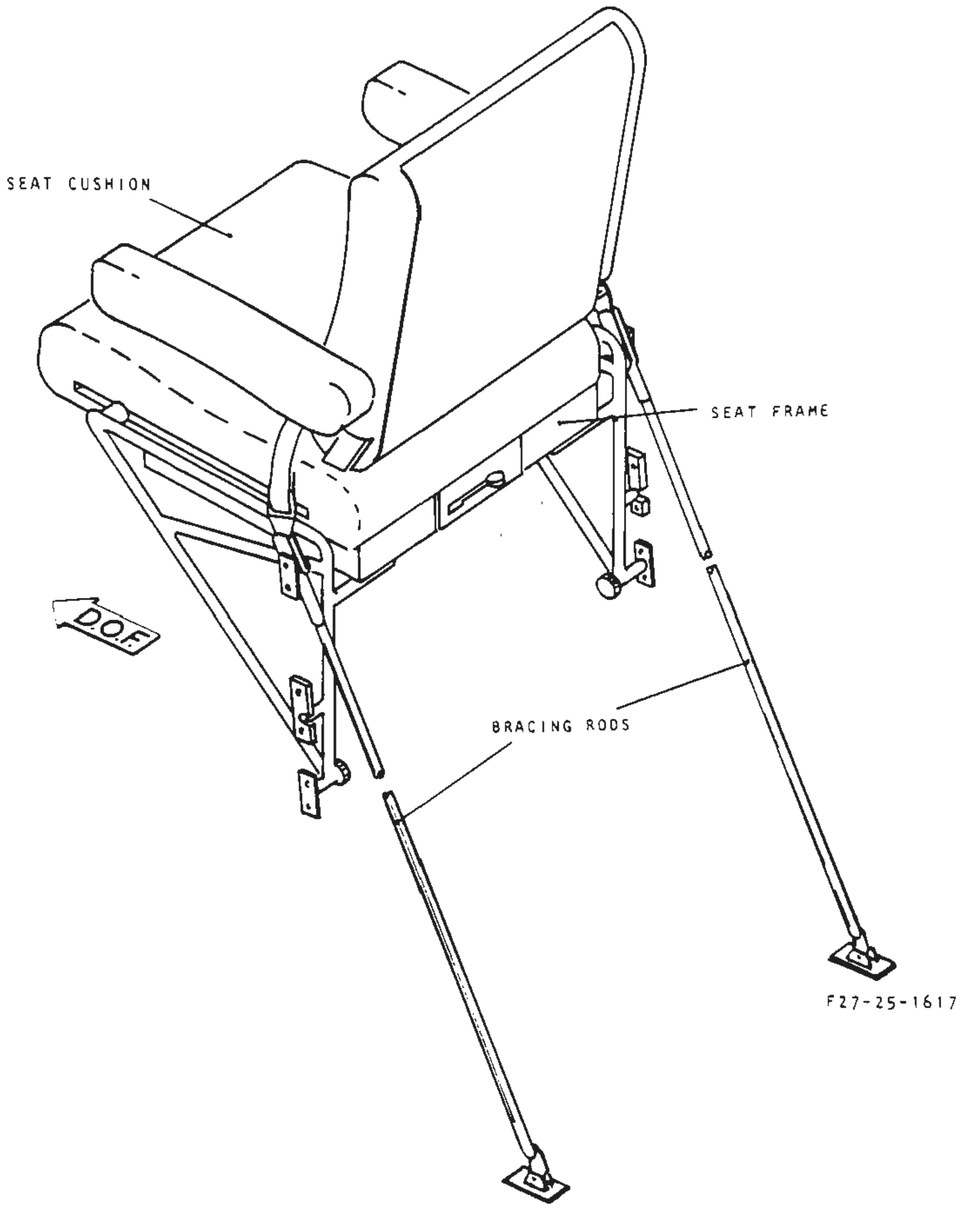
INTERIOR ARRANGEMENT STANDARD CONFIGURATION



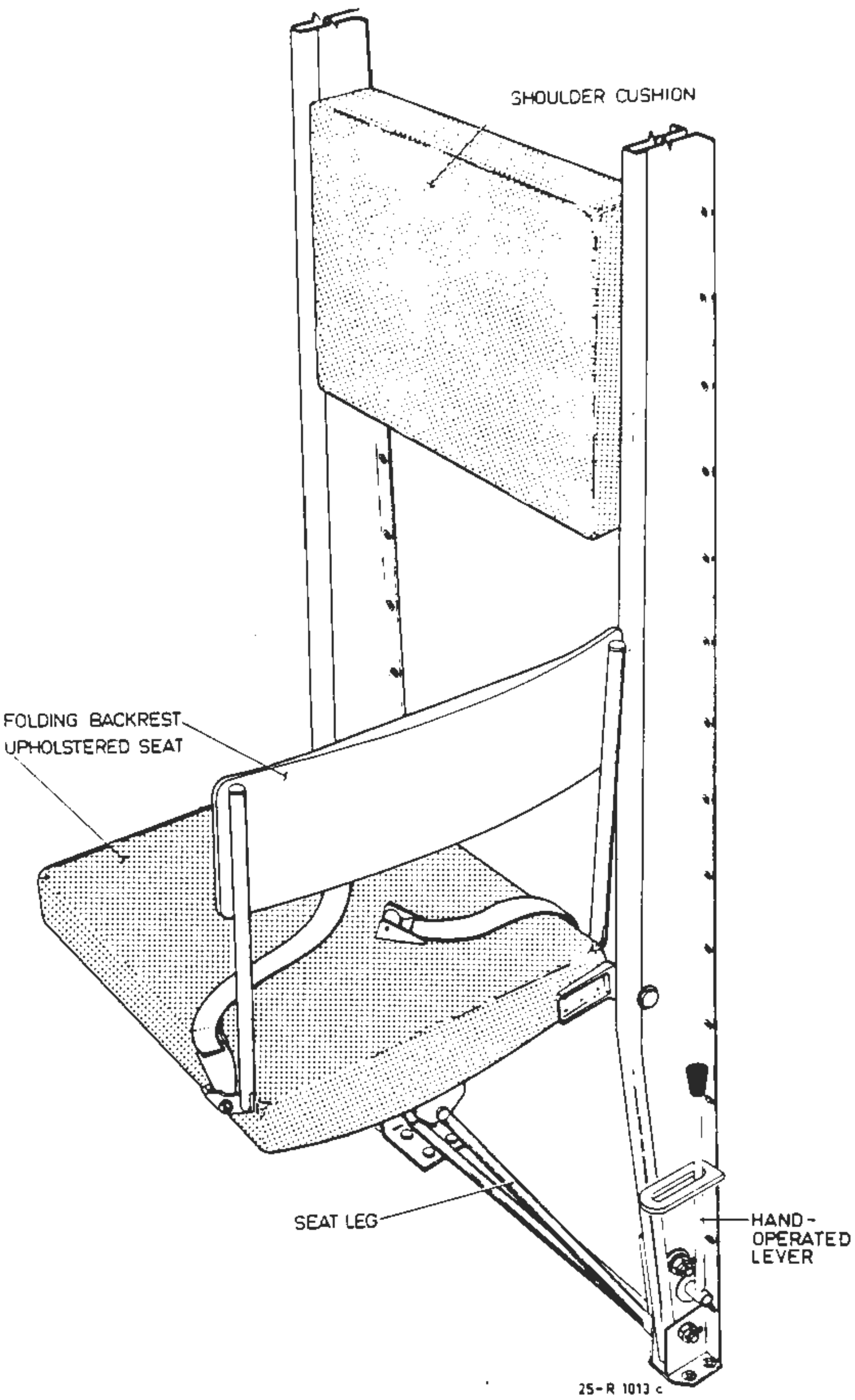
CARGO NETTING INSTALLATION DETAILS



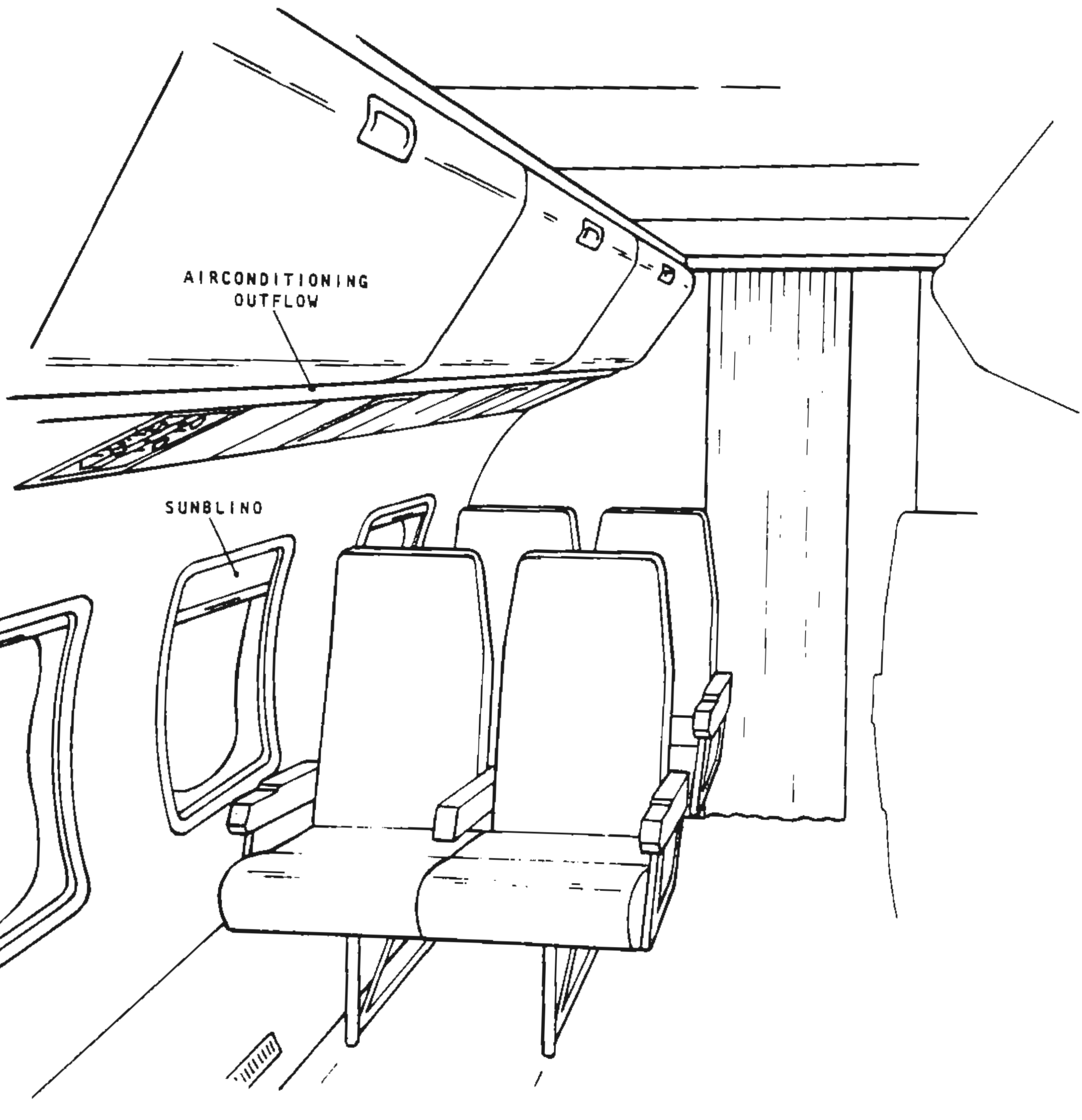
PILOT SEAT INSTALLATION



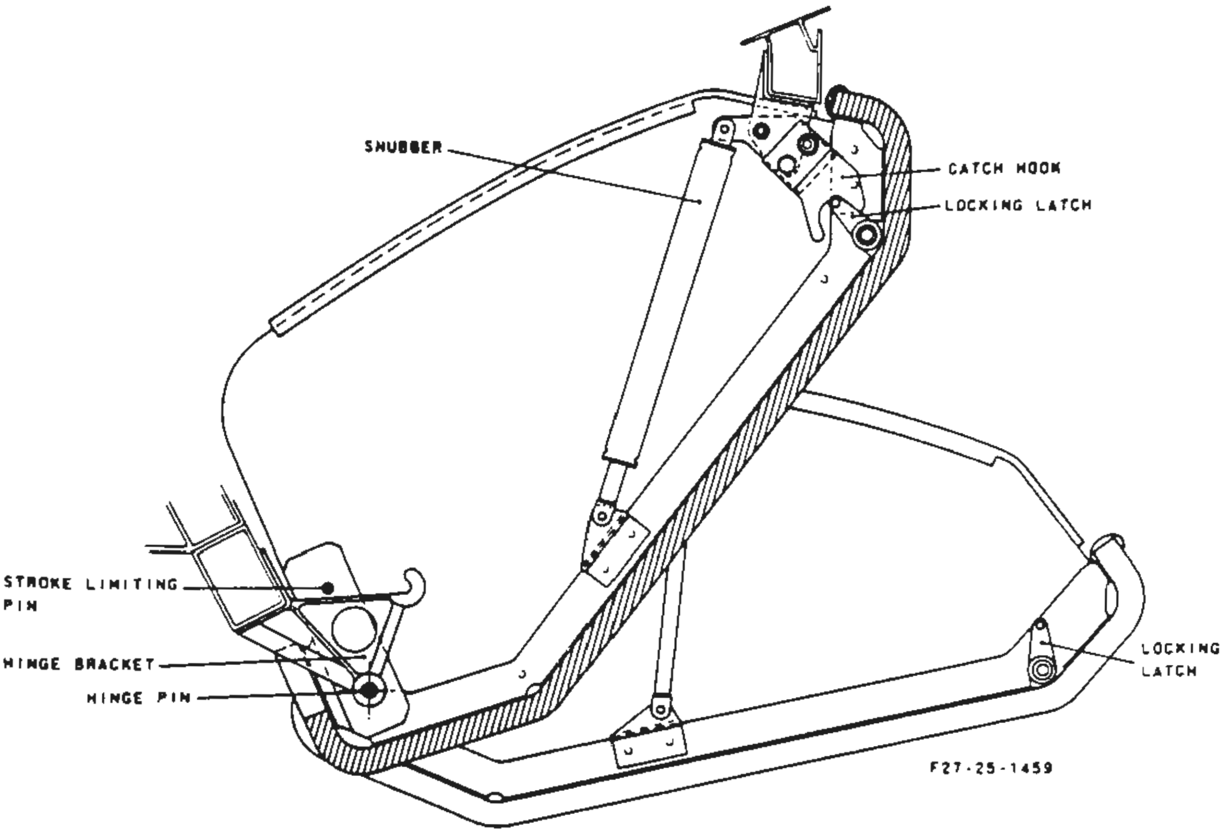
3rd CREW MEMBER SEAT



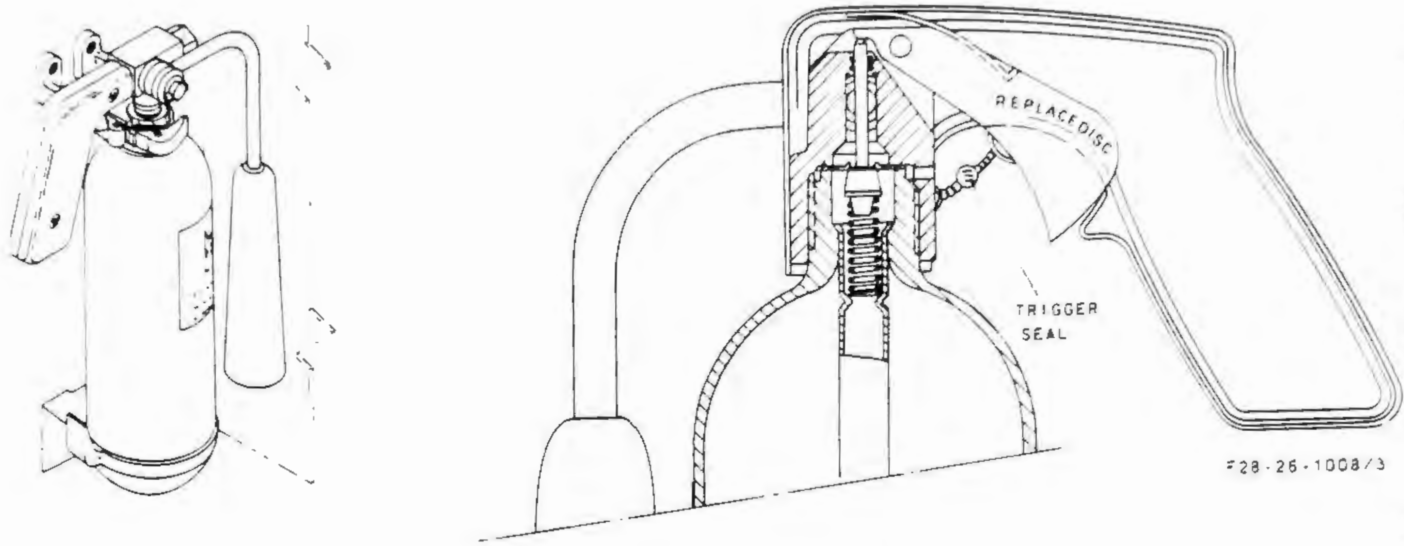
STEWARDESS SEAT



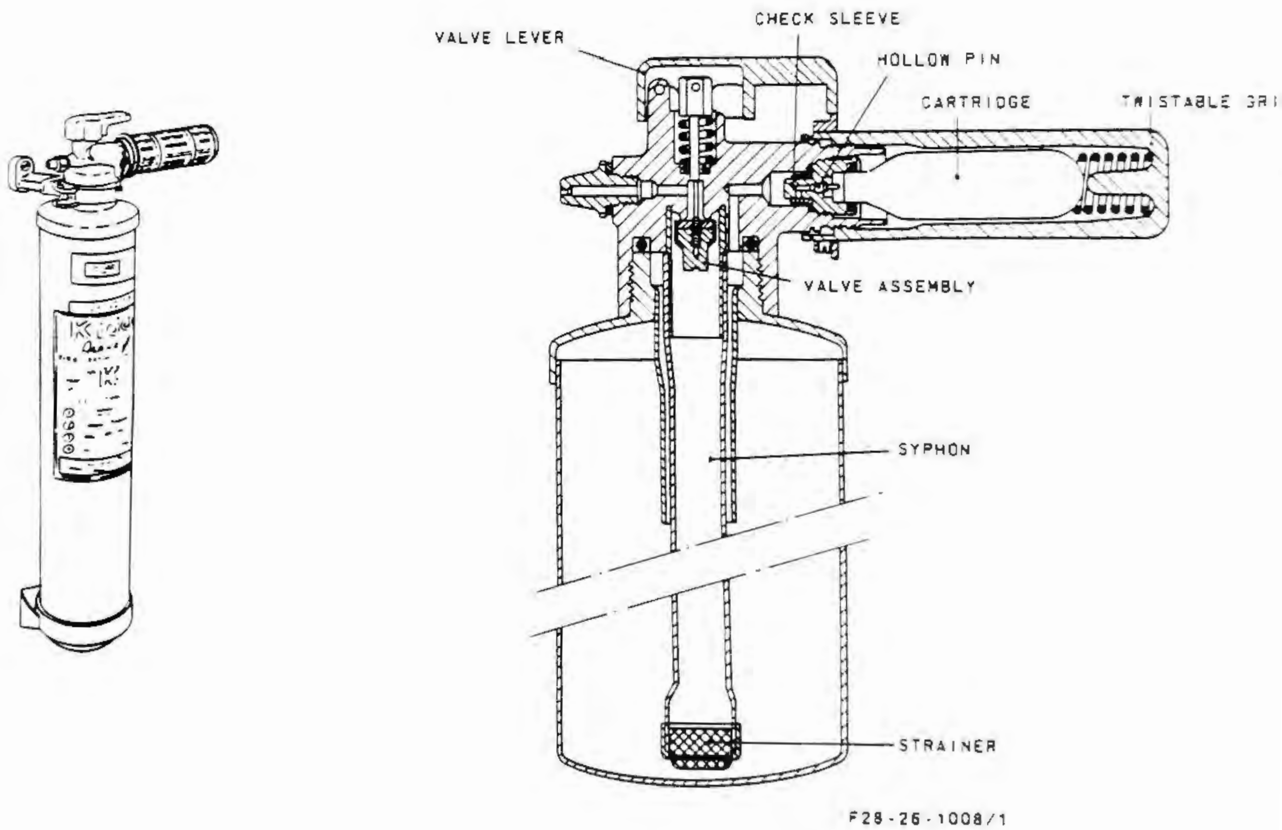
PASSENGER COMPARTMENT LAY-OUT
STANDARD



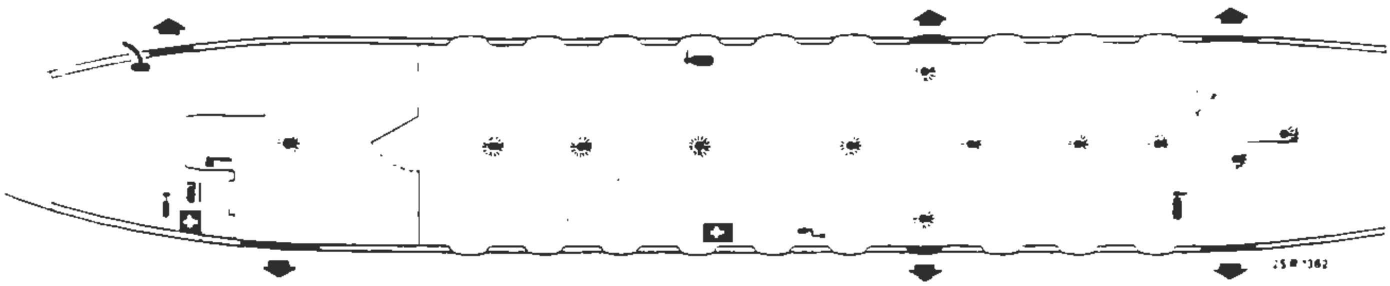
OVERHEAD LUGGAGE BIN



CO_2 FIRE EXTINGUISHER



WATER EXTINGUISHER



PORTABLE OXYGEN CYLINDER WITH MASK

FIRST AID KIT

PORTABLE FIRE EXTINGUISHER (CO_2)

PORTABLE FIRE EXTINGUISHER (WATER)

WINGFLAP EMERGENCY DRIVE CRANK HANDLE

EMERGENCY/ EVACUATION LIGHTING UNITS

EMERGENCY EXITS

ESCAPE ROPE

AXE

LOCATION OF EMERGENCY EQUIPMENT

26 FIRE PROTECTION

26. FIRE PROTECTION

00.0 GENERAL

The fire warning system for each nacelle serves two purposes:

It senses a fire condition in the engine area and a part of the nacelle.

It senses a fire or overheat condition inside the engine at the engine breather.

In the event of a fire, a control box is signalled to illuminate a fire warning light on the glare shield panel and a fire warning light in the HPC lever, and to give a warning via a fire warning bell.

10.0 ENGINE FIRE DETECTION SYSTEM

Each system is of the "Graviner Triple FD" type comprising a number of lengths of detector or sensing elements known as "Firewire". The lengths of wire are joined by coupling units and bulkhead fittings so as to run in a closed loop through the zones 1 and 2, forward of the firewall. The sensing element is also extended beyond the firewall into zone 3 to cover the area in which the fuel pressure transmitter, differential pressure switch and flowmeter are located. Detection of an overheat or fire in the engine breather is achieved by a short length of "Firewire" looped so as to be fitted inside the breather outlet. The ends of the sensing element pass through a mounting flange and terminate in coupling units for connection in series with the sensing element looped around the engine.

The firewire consists of stainless steel capillaries and a central wire electrode, isolated from each other by temperature sensitive material, the electrical resistance of which decreases with an increase in temperature and conversely increases as the temperature decreases.

The other component is a hermetically sealed control box, one for each nacelle system, located on the Main Junction Box. It consists of a transformer and rectifiers which supply the firewire with half waves of electrical power at 400 Herz.

The unit provides a warning for overheat or fire at some part of the fire wire by means of the warning lights. Each system can be tested for continuity by operation of a fire detector test switch on the glare shield panel.

Operation.

The warning lights are supplied with 28 V DC battery bus power via the warning relay in the control box. The control box is supplied with 115 V AC power from the ess. AC bus.

The firewire acts as a capacitor which stores electrical energy in the positive half of the AC power cycle and releases it on the negative half cycle.

When the firewire is cold the impedance between the central wire and the stainless steel capillaries is high and it appears as an open circuit.

The storage capacity increases with increase of temperature and this energy is discharged during the negative half cycle.

At a certain temperature energy release is sufficient to trigger the silicon control rectifier which actuates a relay controlling the warning lights (and bell).

To obviate fluttering of the light a second contact on the relay increases the triggering action of the transistor. Therefore the firewire temperature has to decrease substantially for the light to go out.

Because a short circuit in the firewire makes energy storage impossible, false warnings cannot occur.

Testing.

A two-position springloaded test switch is provided on the glare shield panel to check the firewire continuity and to simulate a decrease of the sensing impedance.

Upon operating the test switch the test relay in the control box will be energized by a supply from the battery bus, also a capacitor is brought in series with the firewire, lowering the total impedance of the system. Provided there is continuity in the central electrode the warning relay will be energized and the circuit to the warning lights and bell will be completed.

Pressing the warning light will silence the bell but the lights will remain illuminated as long as the test switch is operated.

If the test switch fails to operate the warning system, it might be due to a short circuit, an interrupted central electrode, a deteriorated element or a fault in the control box.

<u>NOTE</u>: For testing, DC and AC power must be available, set power selector to BATT and switch on inverter system.

00.0 GENERAL

The fire warning system for each nacelle serves two purposes:

It senses a fire condition in the engine area and a part of the nacelle.

It senses a fire or overheat condition inside the engine at the engine breather.

In the event of a fire, a control box receives a signal to illuminate a fire warning light on the glare shield panel and a fire warning light in the HPC lever, and to give a warning via a fire warning bell.

10.0 ENGINE FIRE DETECTION SYSTEM

Each system is of the "Graviner Triple FD" type comprising a number of lengths of detector or sensing element known as "Firewire". The lengths of wire are joined by coupling units and bulkhead fittings so as to run in a closed loop through the zones 1 and 2, forward of the firewall. The sensing element is also extended beyond the firewall into zone 3 to cover the area in which the fuel pressure transmitter, differential pressure switch and flowmeter are located. Detection of an overheat or fire in the engine breather is achieved by a short length of "Firewire" looped so as to be fitted inside the breather outlet. The ends of the sensing element pass through a mounting flange and terminate in coupling units for connection in series with the sensing element looped around the engine.

The "Firewire" consists of stainless steel capillaries and a central wire electrode, isolated from each other by a temperature sensitive material, the electrical resistance of which decreases with an increase in temperature and conversely increases as the temperature decreases.

The other component is a hermetically sealed control box, one for each nacelle system, located in the Main Junction Box.

It consists of a transformer and rectifiers which supply the fire wire with half waves of electrical power at 400 c.p.s.

The unit provides a warning for overheat or fire at some part of the fire-wire by means of the warning lights.

Each system can be tested for continuity by operation of a fire detector test switch on the glare shield panel.

OPERATION

As shown in the theoretical diagram the circuit of the control unit comprises a transformer with three windings. Windings 3-4 and 4-5 are wound so that at any instance the voltages at 3 and 5 are identical when referred to 4. Winding 5-6 is used to drive the power to switch relay K2.

When the firewire is cold, the impedance between sheath and centre conductors is high and it appears as an open circuit. There are therefore no circulating currents and there can be no potential across resistor R2. Hence the Silicon Rectifier (CR4) will not be triggered.

Firewire hot

a. Charging Period (the positive going half cycle)

In this condition 3 and 5 are positive with respect to 4 and the diode CR1 is free to conduct. The firewire being hot, is able to accept energy and this is supplied from winding 3-4 via CR1 and R3 and from winding 4-5 via R2 and L1. The forward impedance CR1 is low and the impedance of L1 to AC is high, the majority of the charge is therefore derived from winding 3-4. As this is the positive part of the cycle a small negative potential will appear across R2, since the current flow is from 5-4 (i.e. anti clockwise). This small voltage tends to prevent the CR4 from triggering under the charge conditions.

b. <u>Discharge Period</u> (the negative going half cycle)

In this condition 3 and 5 are negative with respect to 4, the firewire is free to discharge. It cannot discharge back to point 3 because of the blocking action of the diode CR1, it therefore discharges through L1 and R2 and assisted in this since point 5 is now negative. Since the charge on the firewire is uni-directional then conversely so is the discharge and the inductance L1 will appear as a low impedance to the resultant D.C. current. The "read out" voltage appearing across R2 will therefore be due to the charge existing on the firewire. Since the ability of the firewire to store a charge is dependent upon temperature then the read-out voltage across R2 is also dependent upon temperature.

When the firewire temperature reaches the warning point sufficient voltage will appear across R2 to cause the CR4 to "trigger". When this happens the impedance of the CR4 drops to a very low value and sufficient current can flow from windings 5-6 through diode CR2 to operate relay K2. This causes a contact of relay RLA to close and energize the warning circuit. The other contact of K2 short circuits R3 and allows a larger charging voltage to become available.

This has two functions:

1. It locks the warning lights circuit.
2. It provides the operate and reset values since with a higher voltage the firewire temperature will have to fall to a lower level before the system can reset.

It can be seen from the foregoing that if a short circuit appears on the element there can be no charge and therefore no discharge. Hence it is not possible for the system to give a false warning under these conditions. The current in the circuit is governed by R3, R1 and L1 and these values are so chosen, that the voltage required to trigger CR4 are never reached under short circuit conditions.

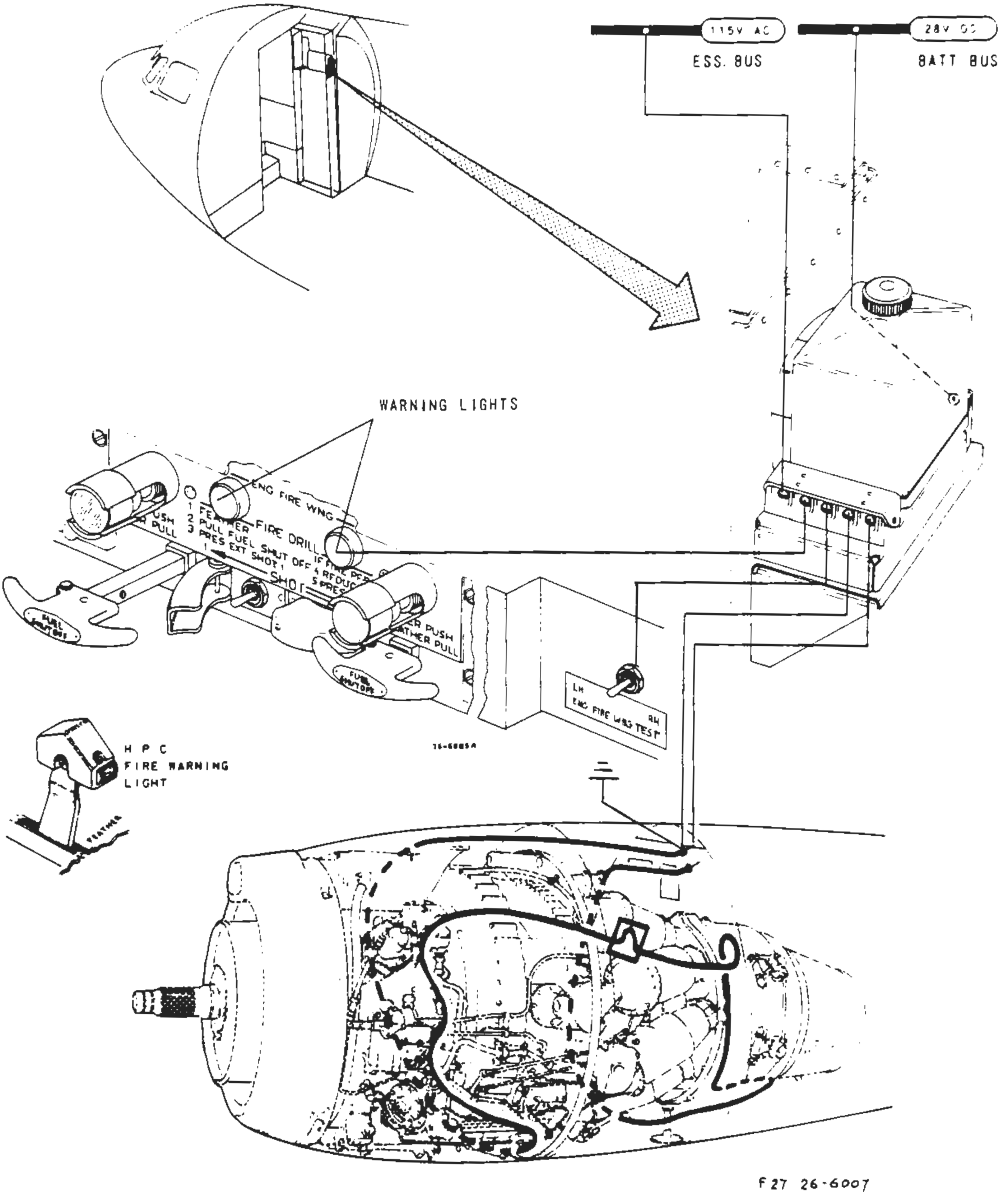
TESTING

A test switch is provided on the glare shield panel to check the firewire continuity and to simulate a decrease of the sensing element impedance. Upon operating the test switch the test relay in the control box will be energized by a supply from the battery bus and a capacitor is also brought in series with the "Firewire", lowering the total impedance of the system. Provided that there is continuity in the central electrode the warning relay will be energized and the circuit to the warning lights and bell will be completed.

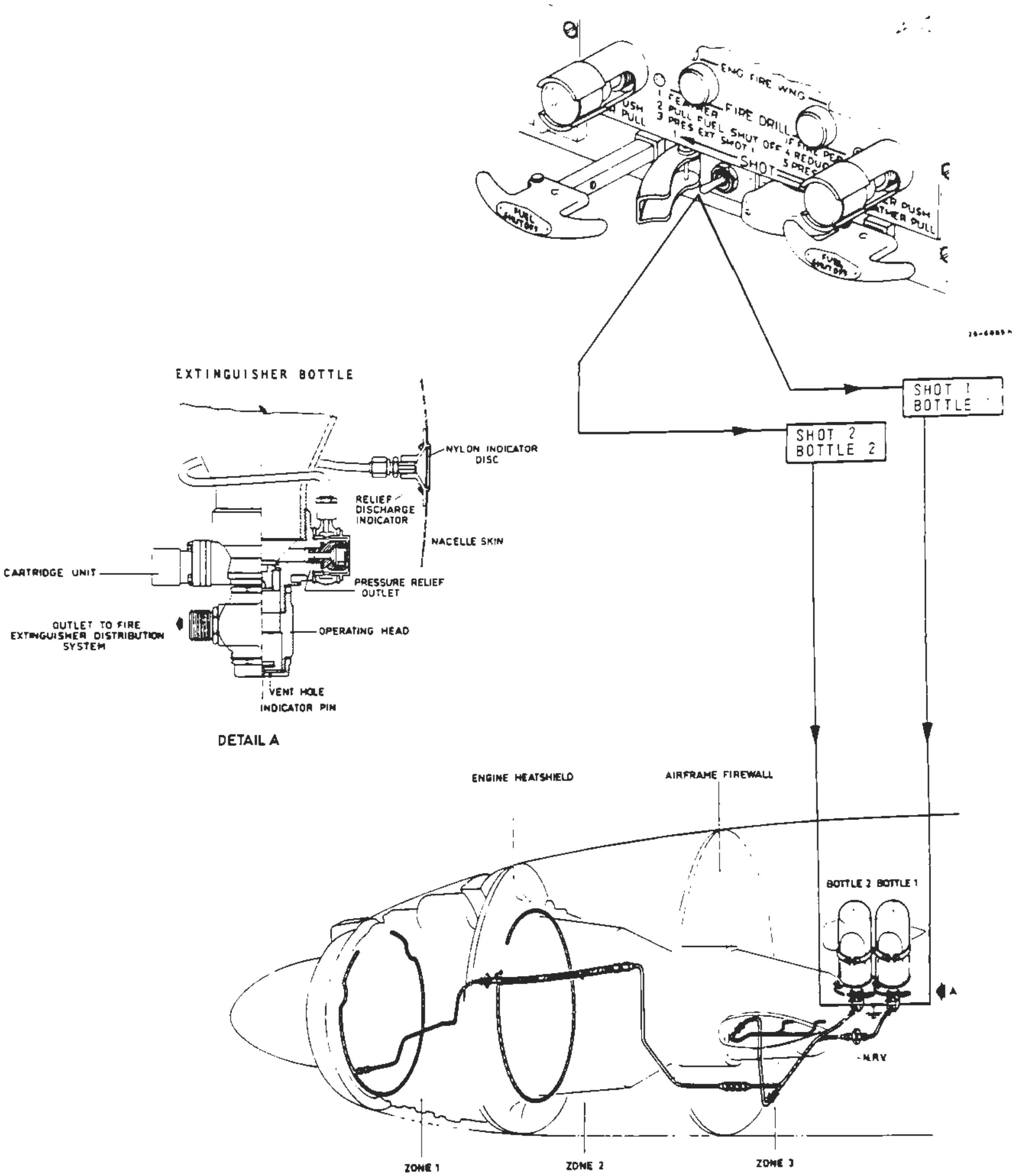
Pressing the warning lights will silence the bell but the lights will remain on as long as the test switch is operated.

If the test switch fails to operate the warning system it might be due to a short circuit, an interrupted central electrode, a deteriorated element or a fault in the control box.

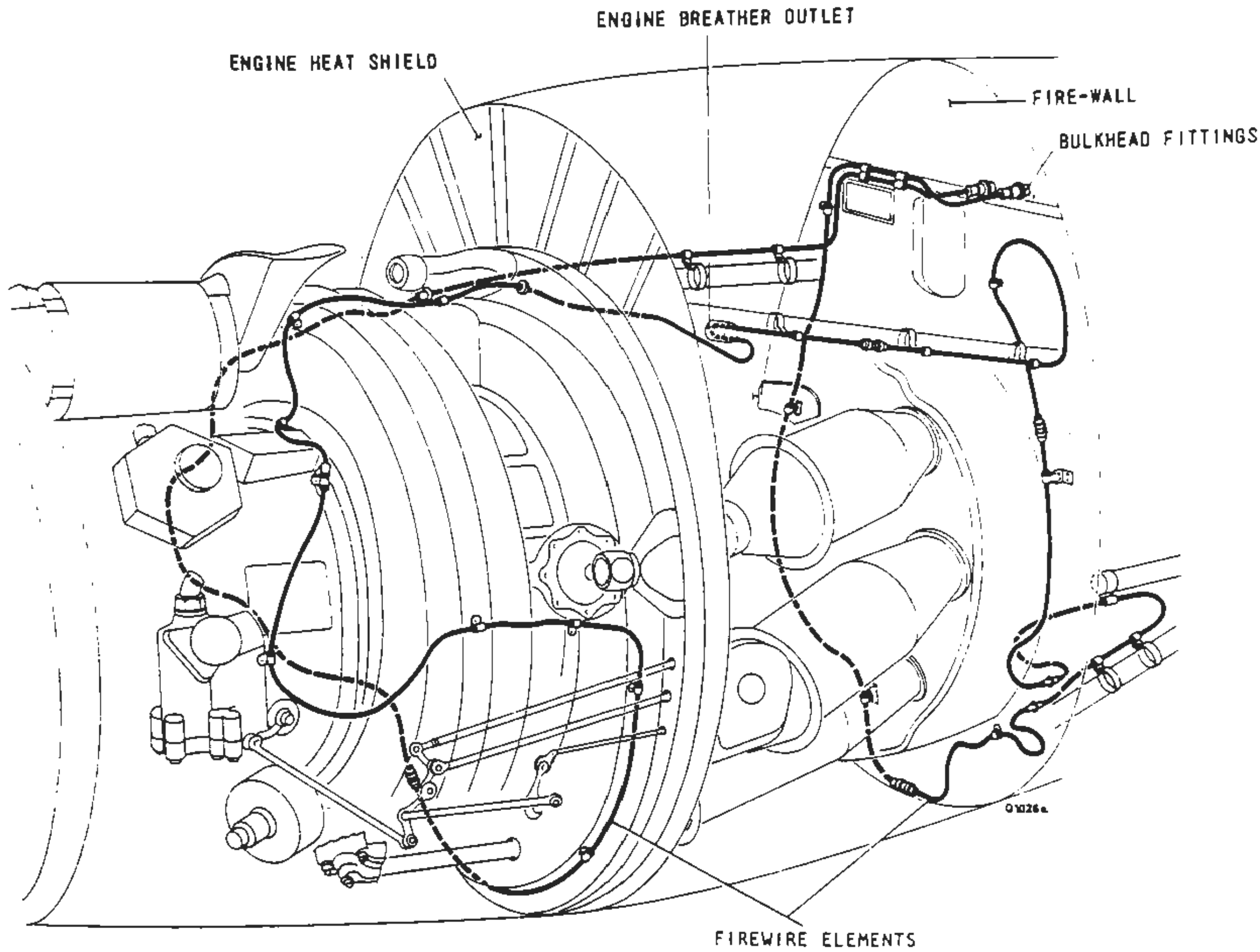
END



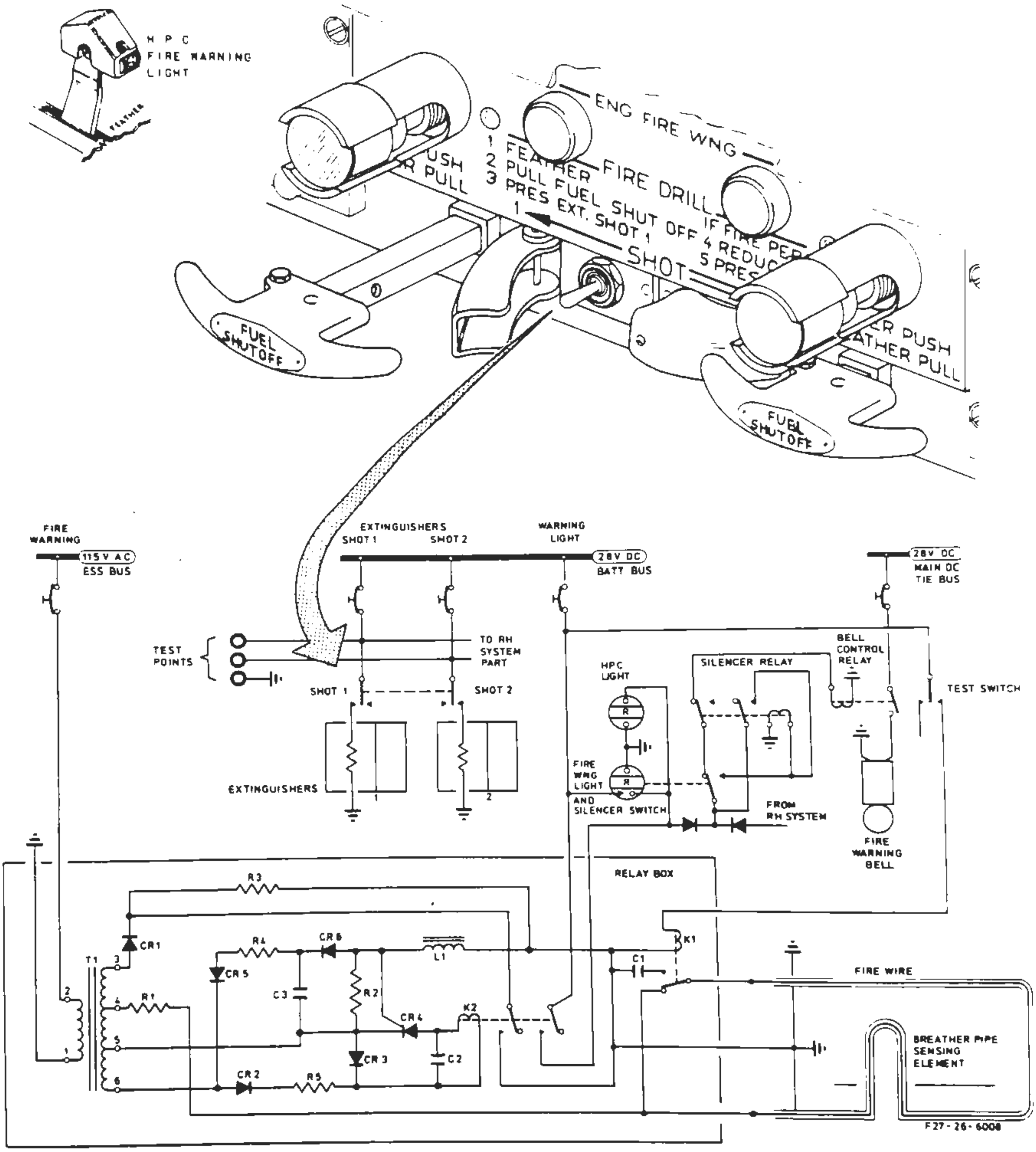
FIRE WARNING SYSTEM



FIRE EXTINGUISHING SYSTEM DIAGRAM



ROUTING OF "FIREWIRE" ELEMENTS



FIRE WARNING AND EXTINGUISHING SYSTEM - THEORETICAL DIAGRAM

20.0 FIRE EXTINGUISHING SYSTEM

The fire extinguishing system for each engine comprises two electrically controlled bromochlorodifluoromethane (BCF) extinguishers, a check valve, spray rings and spray pipes.

When operated, the extinguishers discharge their contents via a pipe line system through two stainless steel spray rings secured to each engine. One of the spray rings is located at the forward part of the engine (ZONE 1) which contains the propeller reduction gear, compressor and fuel system components, and is arranged to spray extinguishant rearwards and so blanket the fuel system components. The second spray ring is located in the hot zone of the engine (ZONE 2) containing the combustion chambers and turbine unit and is arranged to spray extinguishant to blanket the combustion chambers. A fireproof bulkhead isolates ZONE 2 from ZONE 1. Extinguishant is also discharged through spray pipes in ZONE 3 which contains the exhaust unit, flowmeter and differential switch. An intake on the outboard side of each nacelle allows air to flow into the nacelle and so improve the circulation of extinguishant.

Since the extinguishers of each system can be fired independently, a check valve is fitted between them to prevent refilling of a discharged extinguisher.

Extinguishers.

Each extinguisher is of a seamless copper cylinder containing 55 N (5.5 kg f; 12.2 lb) of BCF pressurized to 1720 kPa (250 psi) at 0° with dry nitrogen.

There are two extinguishers for each system which are mounted side by side, head-downwards, on the inboard sides of the nacelles (ZONE 3). Air for cooling purposes is obtained from an air scoop on the outside of the nacelle skin and is circulated around the extinguishers by means of detachable cooling jackets. The extinguishers are designated No. 1 and No. 2 and are colour-coded RED and BLUE respectively, the colours being painted on the supporting brackets and electrical connectors.

Attached to the mouth of each container is an automatic operating head containing a plug with an integral machined diaphragm and surrounding annulus which is connected to an aperture in the side of the head.

A separate (electrically-fired) cartridge unit is attached to a flange around this aperture. A light-alloy junction box with a 90° angle outlet is screwed on to the head and has in its base a threaded cap containing an indicator pin. This pin, which is normally flush with the cap, protrudes after discharge of the extinguisher.

Completion of the circuits to the cartridge units is accomplished by selector switches located on the glare shield panel.

The operating head also carries a pressure relief plug containing a platinum disc, the purpose of this device being to protect the extinguisher against excessive internal pressure due to excessive ambient temperature. The pressure relief valve device operates within the range of 1070 to 1220 psi at 140 °C. A special union fits over the pressure relief plug for connection of a discharge pipe to a pressure discharge indicator mounted in the skin of the nacelle and at the inboard side. The discharge indicators (one for each extinguisher) consist of a body which is flange-mounted to the nacelle skin and a red plastic disc held in place by a circlip.

Operation.

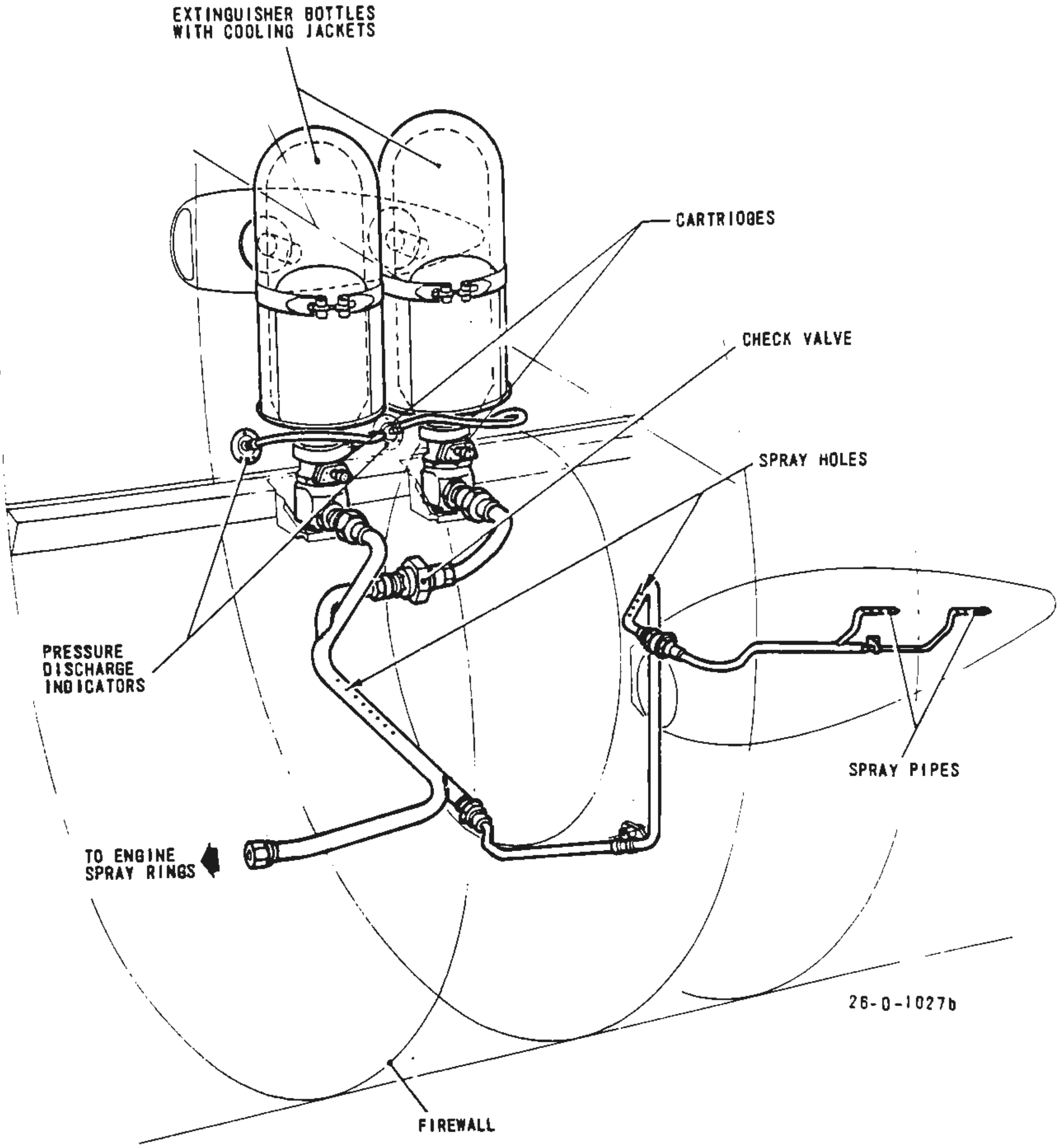
In order to extinguish an engine fire, the propeller concerned must firstly be feathered and the emergency fuel shut-off control handle on the glare shield panel pulled out. This exposes a red safety guard covering a three-position switch on which each extinguisher may be selected. The switch positions are placarded "1 SHOT 2". The switch is springloaded to the mid position.

Because of the check valve arrangement in the pipe line system, the selector switch must be set to the "SHOT 1" position first. This completes the circuit to the cartridge unit of the appropriate extinguisher. When the cartridge is fired the high gas pressure created in the annulus causes the plug diaphragm to rupture from the main body of the head and the plug to be forced into the junction box cap. This leaves a clear passage for the BCF to flow through the outlet, check valve, spray pipes and spray rings. The detached plug at the same time strikes the indicator pin in the junction box cap, causing it to protrude and thus indicate that the extinguisher has fired. The discharge time of an extinguisher is approximately 3 seconds.

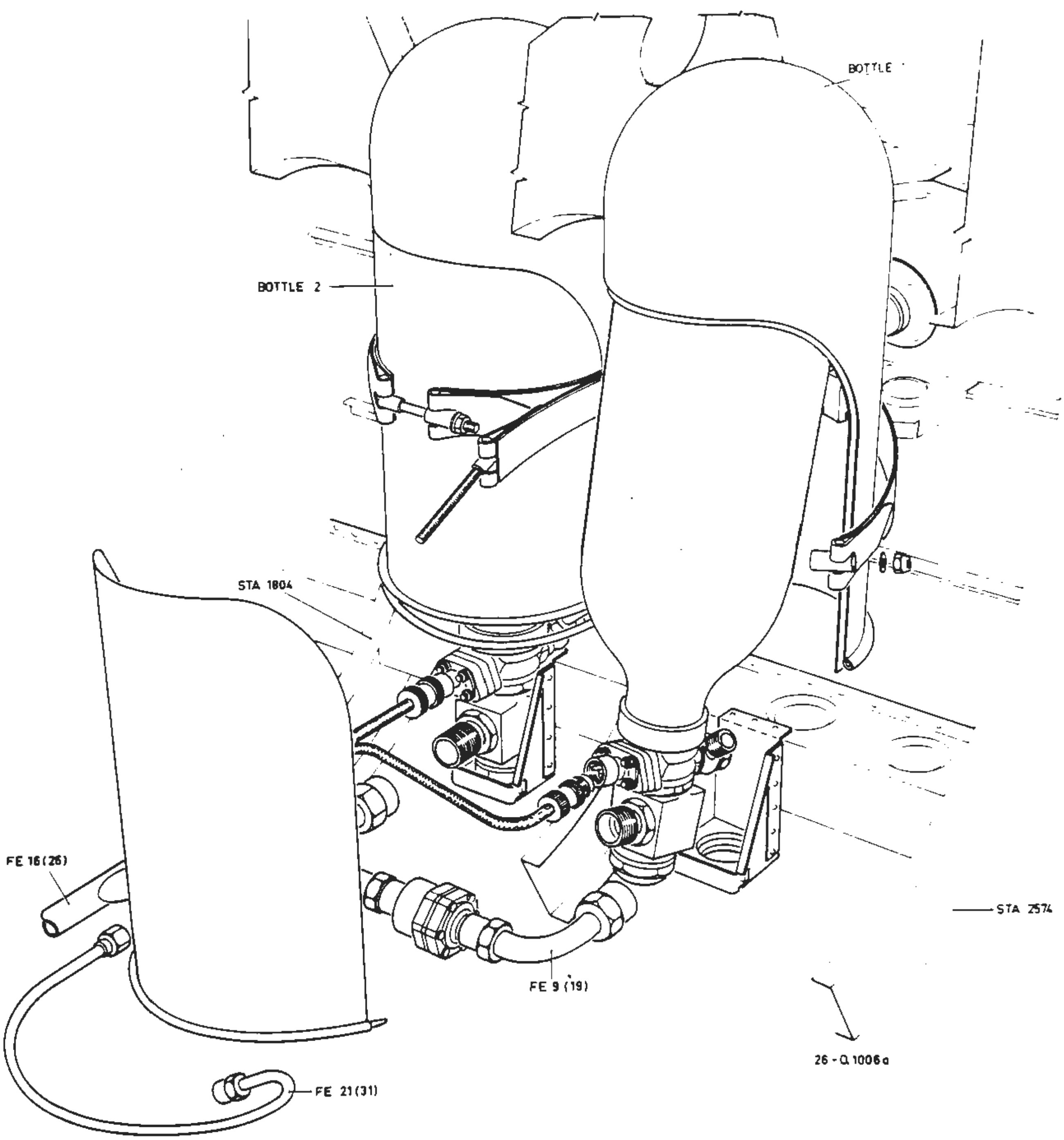
If, after firing extinguisher No. 1, the engine fire still persists, then the selector switch must be held to the "SHOT 2" position, so discharging the contents of extinguisher No. 2. Since the flow of extinguishant will then be in the opposite direction, the check valve will be maintained in the closed position, thus preventing recharging of No. 1 extinguisher.

Should the extinguisher temperature accidentally exceed the upper limit (approx. 140° C.) excessive internal pressure in the extinguisher causes the platinum disc of the pressure relief device to burst. The extinguishant then flows out through the discharge pipe to the discharge indicator, causing the red plastic disc to be ejected and so provide positive indication of discharge.

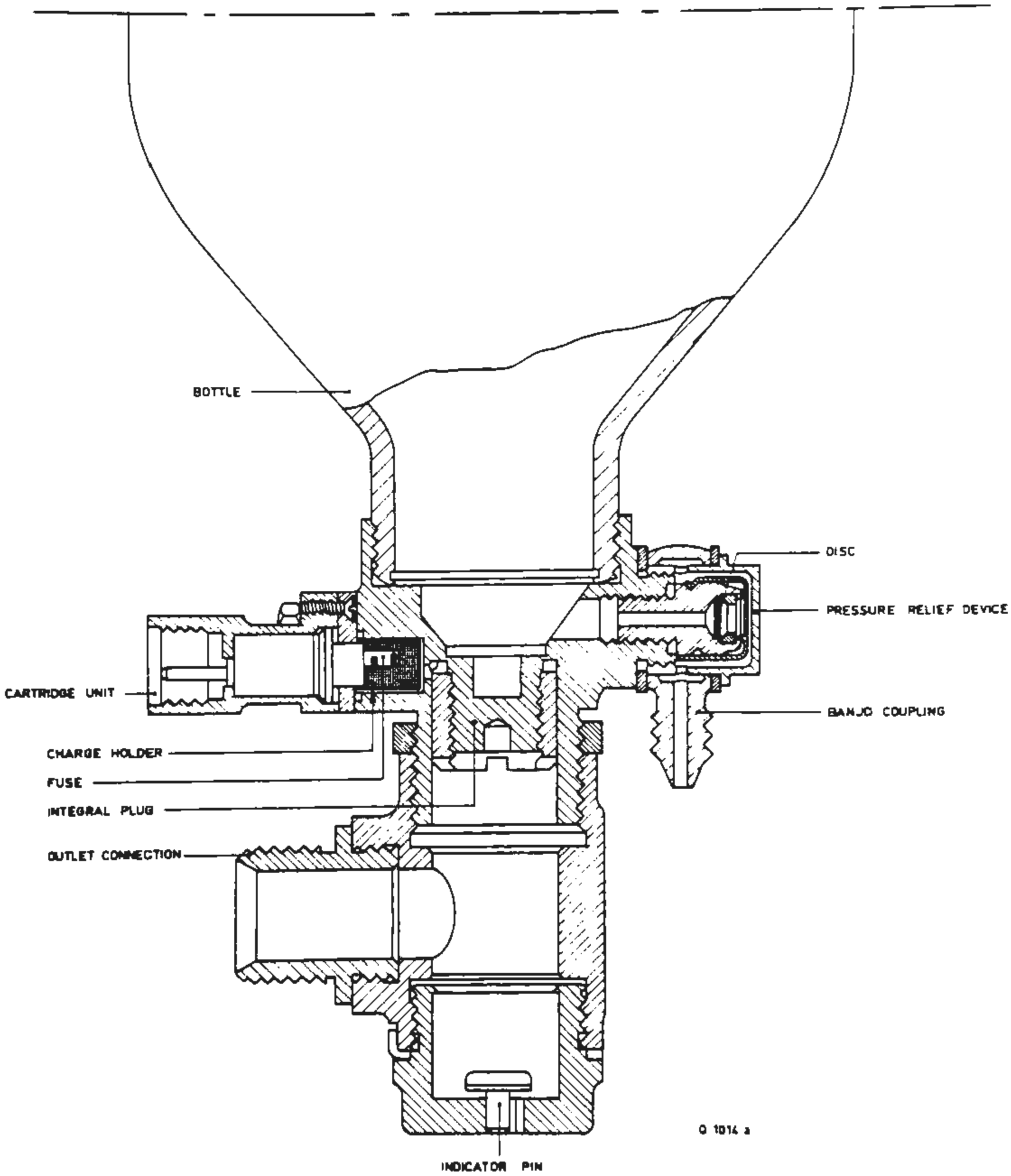
END



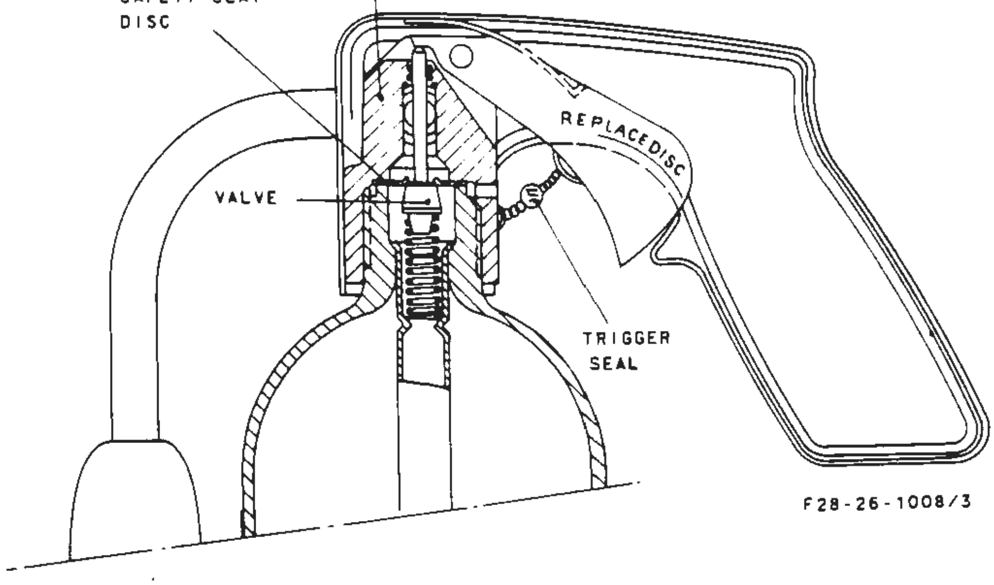
FIRE EXTINGUISHING SYSTEM INSTALLATION IN NACELLE

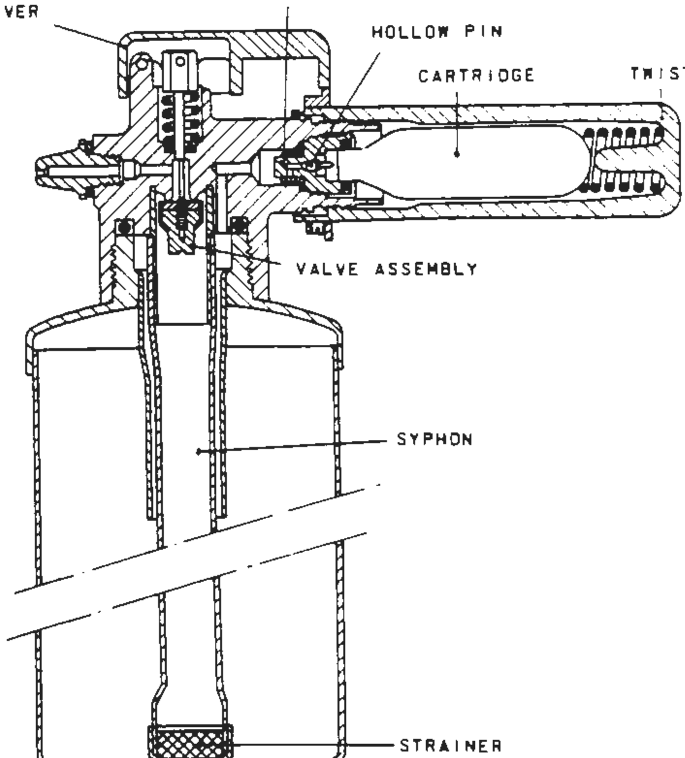


INSTALLATION OF FIRE EXTINGUISHING BOTTLES



SECTIONED VIEW OF AUTOMATIC HEAD ON EXTINGUISHER BOTTLE





PORTABLE FIRE EXTINGUISHERS - DETAILS

22.0 PORTABLE FIRE EXTINGUISHERS

There are four portable fire extinguishers installed in the aircraft, one in the cockpit on the left-hand side, one in the pneumatic compartment door, and two at the rear of the passengers compartment.
The fire extinguishers in the cockpit, and pneumatic compartment door are of the carbon dioxide (CO_2) type.
The fire extinguishers in the cabin are of the water/glycol type.

A. Carbon Dioxide Extinguisher

The carbon dioxide (CO_2) fire extinguisher is specially intended for use on fires where a smothering action is required (class B and class C hazards), such as burning liquids and electrical fires where a non-conducting extinguishant is required.
The extinguisher is a lightweight trigger operated unit consisting of a cylinder with a screwed-on valve body and trigger. The valve assembly consists of a springloaded valve, seating against a safety seat disc. The safety seat disc is fitted between valve body and cylinder. The valve stem protrudes from the valve body under the trigger. A grip is fitted over the valve body and trigger. Pulling the trigger inward causes the valve to open thus enabling the CO_2 to discharge through a horn. The horn is swivel mounted on the body. Ambient temperature limits for the extinguisher are -40 °C (-40 °C) to +54.4 °C (130 °F).

If the extinguisher is exposed to excessive high temperatures the extinguishant discharges through the horn upon rupture of the safety seat disc. In that case an indication REPLACE DISC is visible on the trigger which has been forced out of the grip by the valve stem.

B. Water/Glycol Extinguisher

The water/glycol fire extinguisher is intended for use on class A fires, which includes cloth, wood or paper.

The extinguisher consists of a cylinder and a screwed-on head with syphon tube.
A synthetic rubber seal is interposed between the mating surfaces of the head and the cylinder.
The cylinder contains a 1-pound, 8-ounce (0.68 kg) antifreeze/water solution pressurized to 100 psi with air or nitrogen. The solution is expelled via the siphon tube and nozzle if the springloaded valve in the head is opened by depressing the trigger. The solution has antifreeze properties to a temperature of -23 °C and will provide a concentrated 15-feet jet of flat trajectory during 15 seconds.

OPERATION

The CO_2 fire extinguisher is operated by moving the horn away from the container and aiming it at the base of the fire. The horn is attached to the handle by a swivel joint. Squeezing the pistol trigger discharges the carbon dioxide. When releasing the trigger it will prevent the gas from further discharging.

Operation of the water/glycol fire extinguisher consists of rotating the handle in a clockwise direction. This causes the small cartridge of air or nitrogen to be punctured.
This gas then pressurizes the container. Depressing a thumb lever discharges the extinguishing agent. The unit can be partly or completely discharged as required.

END

23.0 MAINTENANCE NOTES

CAUTION: These notes are included for TRAINING ONLY. For actual maintenance operations always refer to the Maintenance Manual.

FIRE EXTINGUISHING SYSTEM

1. Weight check

   Ensure that the last weight check of the extinguisher is valid.

   EMPTY: 7 lb 9 oz ± 2¼ oz.

   FULL: 19 lb 9 oz ± 4 oz.
   (including cartridge unit weight of 2.75 ozs).

   WEIGHT CHECK: The extinguisher must be weighed periodically as specified in the F 27 Inspection Guide. The weight must agree to within ± 1 oz with that stamped on the operating head. The stamped weight refers to the extinguisher without cartridge unit but including plastic transport cap. If required, the cartridge unit may be left installed and allowance made for its weight.

2. Other checks of system

   The spray pipes and spray rings should be inspected periodically for chafing, security of clips and locking.

   To check the spray-holes for freedom of obstruction the supply pipe at no. 2 extinguisher should be disconnected and air pressure of 50-70 psi applied to the spray system and venting checked.

   If some holes are found blocked they must be cleared carefully using either a no. 60 drill (0.40-inch) or a straight piece of 20 swg wire (0.36 inch).

   Reconnect supply pipe to no. 2 extinguisher on satisfactory completion of this check.

   Check that vent hole at indicator pin location of extinguisher operating head is free from obstruction and that pin is not protruding.

END

23.0 MAINTENANCE NOTES

CAUTION: These notes are included for TRAINING ONLY. For actual maintenance operations always refer to the Maintenance Manual.

WARNING SYSTEM

1. Continuity Test

a. In carrying out a continuity test of the "Firewire" it is necessary to have the battery and inverter power supplies available.

b. Ensure that the C/B's (on panel 1 of the M.J.B.) of the "FIRE BELL", "LIGHT" and "DETECTION" circuits respectively are engaged.

c. Set power selector switch to BATT and switch on inverter system.

d. Operate the fire warning test switch to both positions and check for illumination of the fire warning lights. If the lights do not illuminate it will indicate interruption of the warning circuit. If the interruption is due to a broken "Firewire" sensing element it should be replaced as soon as possible to prevent ingress of moisture to adjacent elements.

2. Insulation resistance test

a. Open C/B's "DETECTION" of both port and starboard systems.

b. Disconnect "Firewire" elements from the nacelle fire-wall connectors (each nacelle in turn) and with a 250-V megger connected between exposed centre electrode and capillary, measure the insulation resistance which should be at least 1 megohm.

NOTE: If the insulation resistance over the total length, as measured above, is less than 1 megohm, each length of sensing element should be checked: the insulation resistance must also be 1 megohm. For the firewall connectors and element unions the insulation resistance should be at least 20 megohms.

c. Re-install fuses on satisfactory completion of checks.

FIRE EXTINGUISHING SYSTEM

1. Continuity checking

Continuity checking of the electrical system should be carried out by connecting test lamps to the plugs, after disconnecting them from the extinguishers, selecting "SHOT 1" and "SHOT 2" in turn, and observing that the lamps illuminate and extinguish in the correct sequence.

WARNING: 1. Before connecting the electrical plug to an extinguisher, ensure that the selector switch on the glare shield panel is in the OFF position and that the C/B's are tripped.
2. Check also that colour on the plug is the same as that on the relevant extinguisher supporting bracket!

2. Cartridge unit check

The unit should be checked periodically as specified in the F27 Inspection Guide. Remove the unit from the cylinder and mount it on a suitable fixture with the charge end shielded but unrestricted in case of accidental firing.

Check the insulation resistance between each pole and ground. Should be at least 20 megohms.

Check the fuse resistance across the poles by a safety ohmeter. Should be between 5 and 6 ohms.

CAUTION: THE CURRENT USED SHOULD NOT EXCEED 13 MILLIAMPS.

The cartridge unit is expendable after two years and should be returned to an approved organization for renewal of the powder charge.

NOTE: Always ensure that the silastic "O" ring is in correct position when fitting a new cartridge unit to a cylinder.

END

27 FLIGHT CONTROLS

27. FLIGHT CONTROLS

27. FLIGHT CONTROLS

00.0 GENERAL

The control systems described in this chapter are:
Ailerons, elevators, rudder, tabs, gustlock and flaps.
All control systems are operated by two-way cable systems with the exception of the flaps and the adjustable part of the aileron trim/balance tab which are operated electrically.

Several types of tabs are used on the main control surfaces:

a. Trim tabs, adjustable from the cockpit.
b. Balance tabs, servo acting.
c. Spring tabs, servo acting.

00.1 Basic Principles of Tabs

The following brief description of the basic principles of the various types of tabs on the F27 aircraft is included as a revision for the student.

Trim Tabs

Are manually adjustable by the crew from the cockpit. They provide a means of correcting for any lateral, longitudinal or directional unbalance of the aircraft and so provide a means of eliminating unwanted control forces.

Balance Tabs

Reduce the force necessary to operate their associated main control surface. The deflection of the tab is proportional to the travel of the main control surface to which it is attached. They cannot be adjusted in flight from the cockpit.

Trim/Balance Tabs

A combined type of tab which operates as a balance tab but which can also be adjusted from the cockpit for trim purposes.

Spring Tabs

Reduce the force necessary to operate their associated main control surface. The deflection of the tab is dependent on the airload on the main control surface to which it is attached.

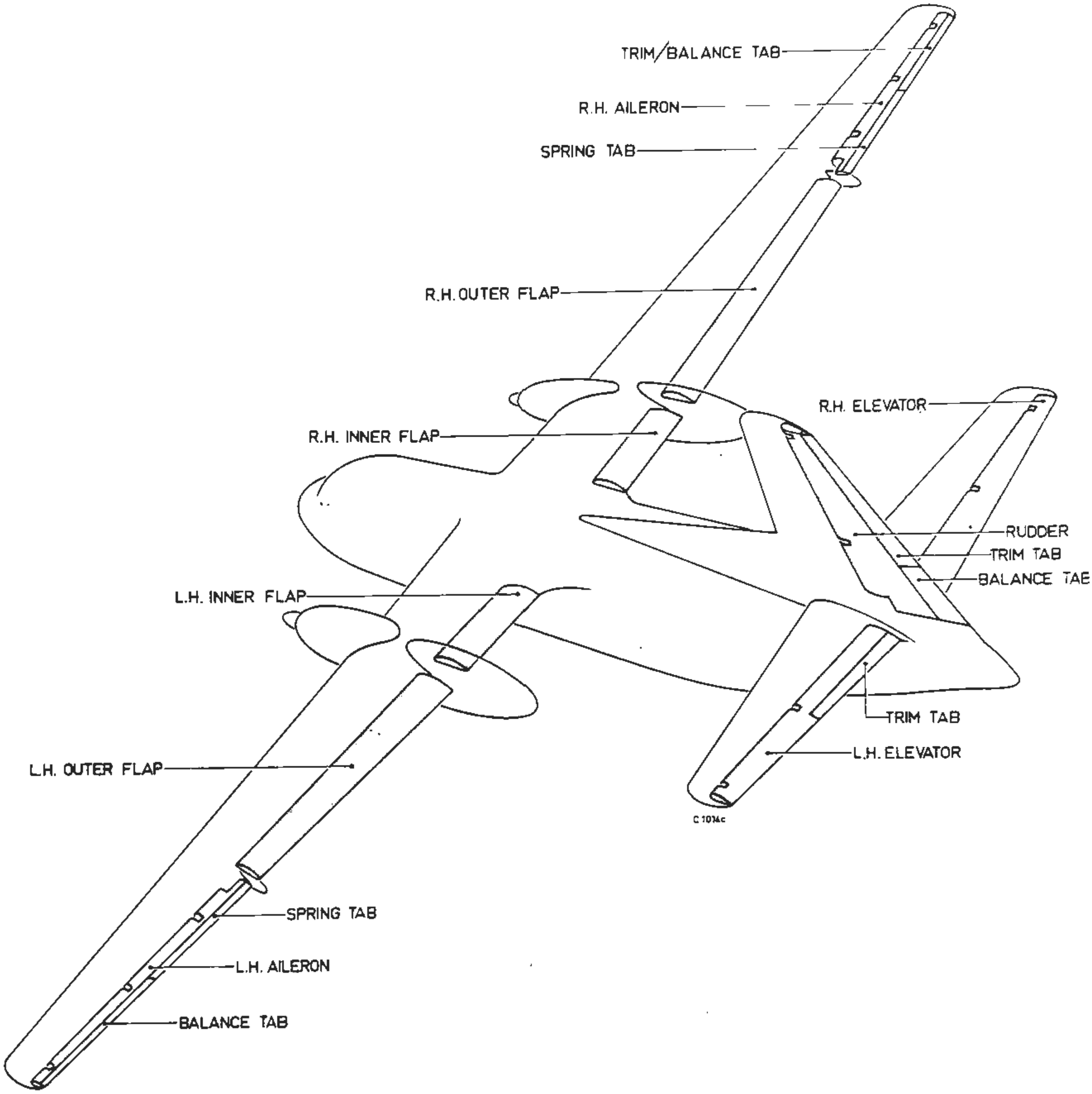
On the F27 aircraft, tabs are fitted to the main control surfaces as follows:

Trim Tabs	- fitted to LH elevator and also the rudder (upper tab)
Balance Tabs	- the lower tab on the rudder and the outboard tab on the LH aileron.
Trim/Balance Tab	- the outboard tab on the RH aileron.
Spring Tabs	- fitted to inboard sides of both LH and RH ailerons.

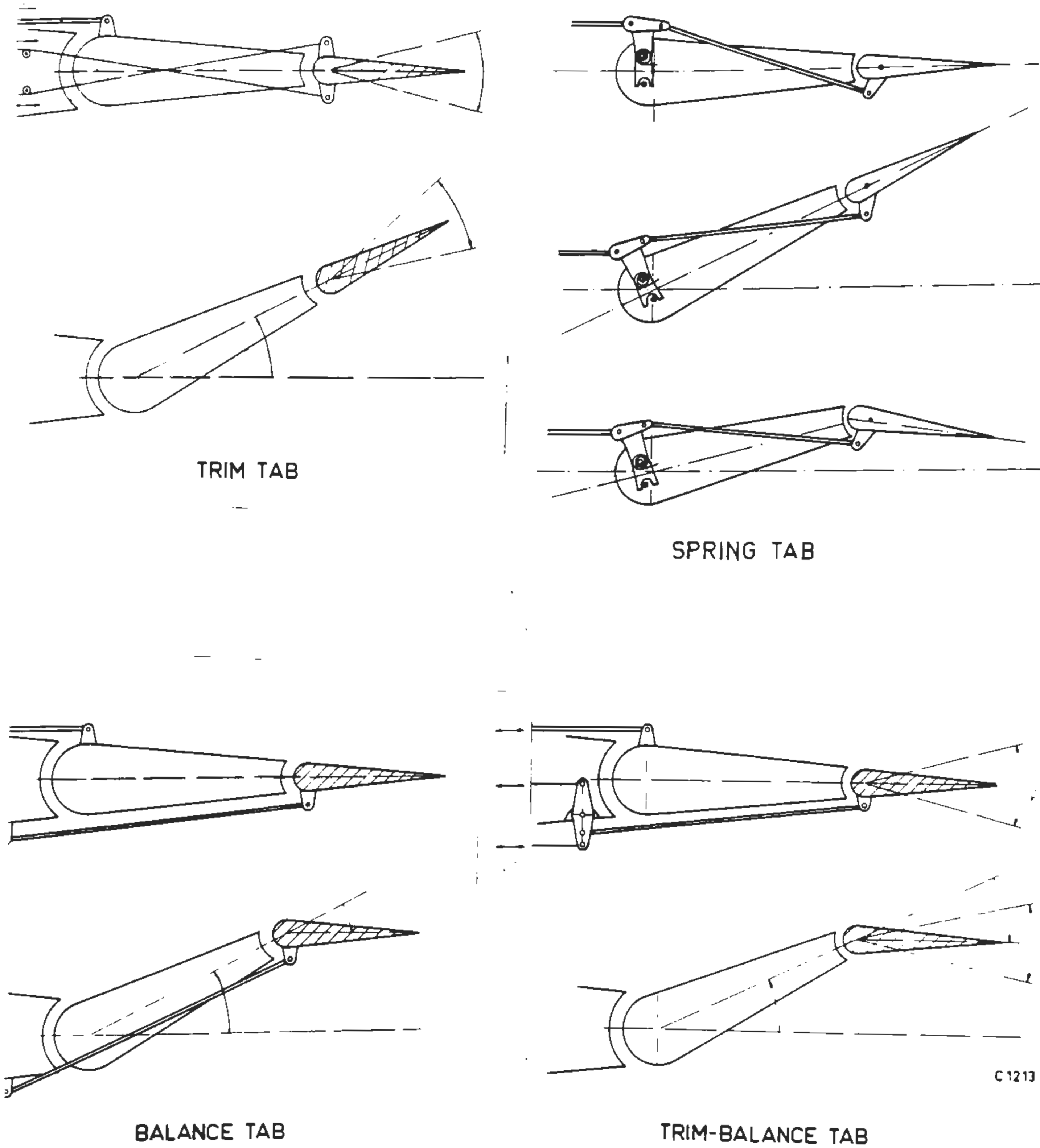
00.2 <u>Cable System</u>

The cables used to operate the main flight controls are called LOCK-CLAD cables. This is a trade name of cables provided with an aluminium tubing swaged around them.
As a general rule the cables are routed from below the cockpit to the rear of station 3100, upward via the pneumatic compartment and routed aft via the ceiling thereby passing the partial pressure bulkhead from where they are connected to the relevant flight control systems. Cable splices fore and aft of the partial pressure bulkhead are installed for quick change of worn cables. The tension of the various cables is adjustable by means of turnbuckles. They are supported by pulleys, fairleads and seals.

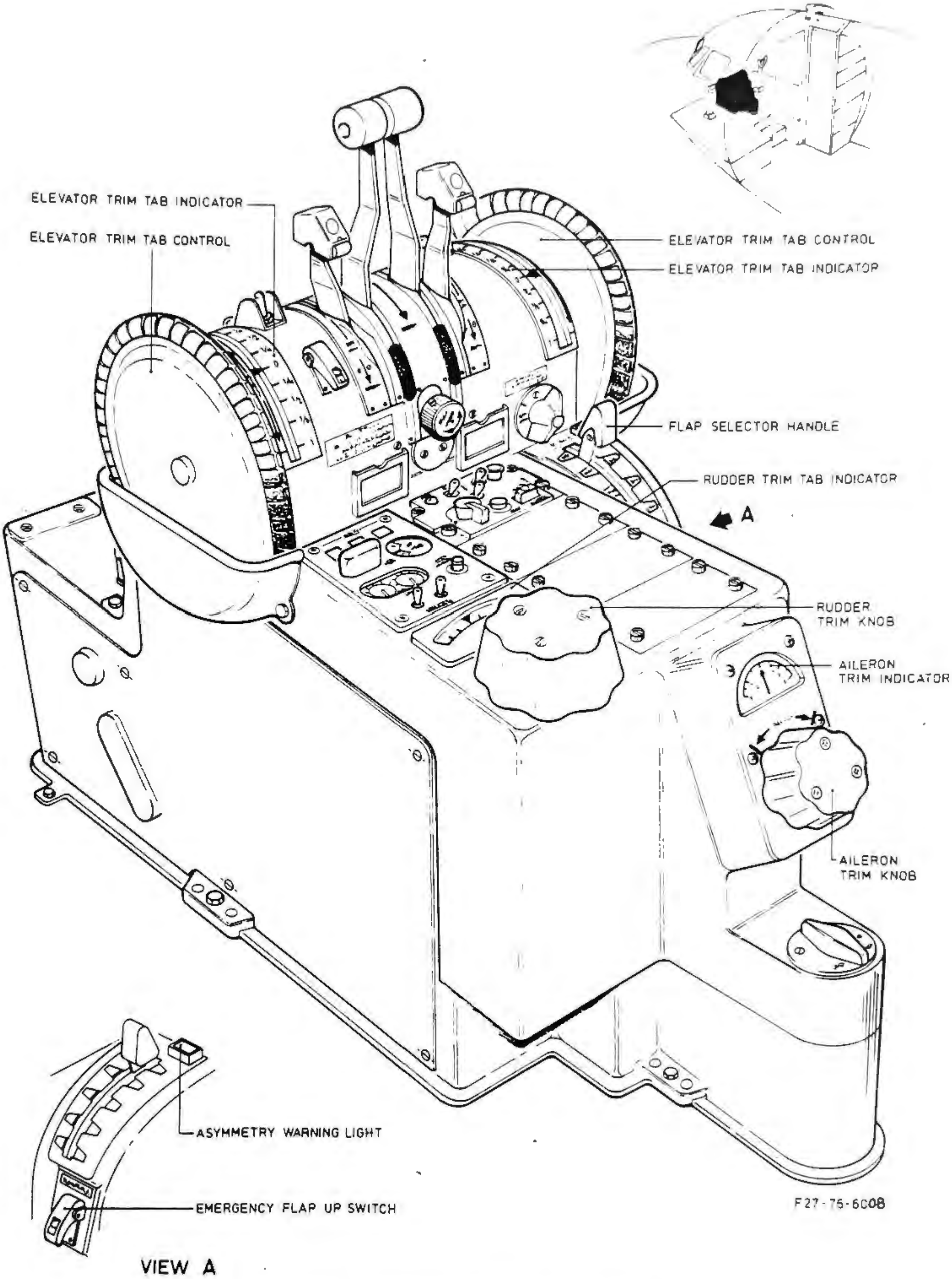
END



FLIGHT CONTROL SURFACES



BASIC PRINCIPLES OF TABS



FLIGHT CONTROLS ON PEDESTAL

10.0 AILERON CONTROL SYSTEM

The ailerons are operated by the pilot's and copilot's control wheels in the cockpit through a conventional cable system. Cables run from a drum on each control wheel shaft down through the control column and then aft below the cockpit floor where they terminate on an intermediate torque tube located just behind Sta. 3100. A large drive sector fitted on the intermediate torque tube transmits control movement via cables to a crosswheel on the centre wing rear spar. From the crosswheel, cables run outboard, guided by roller assemblies to differential sectors connected to the aileron by means of a control rod. Between aileron torque tube, aileron crosswheel and differential sectors, Lock-Clad cables are used. A mechanically operated gustlock is provided near the aileron crosswheel, to lock the ailerons in the neutral position.

10.1 Control Wheels

A conventional control wheel is mounted at the top of each control column. The wheel and a cable drum are splined to a shaft which rotates in two ball bearings in the head of the control columns. Rotation of the wheel is limited by a stop arm, also splined to the shaft, which contacts permanent stops at the front of the column. The column head is removable to gain access to the cable drum. The aileron cables are wrapped around the drum and fastened with clamps. The cables are routed down through the column to pulleys in the column base.

10.2 Intermediate Torque Tube

The intermediate torque tube is located under the floor of the cargo compartment just behind the cockpit rear wall and is accessible via the pneumatic compartment and a removable floor panel. The tube assembly is mounted in two ball bearings and is provided with four small cable quadrants, a large drive sector and an elevator bellcrank. The cables running from the control wheels in the cockpit are connected to the small quadrants, which are bolted to the extreme ends of the tube. In this way the torque tube synchronizes the movement of the control wheels. The main aileron cables, running to the centre wing, are connected to the large drive sector, which is an integral part with the left hand small quadrants. The bellcrank of the elevator control system is installed near the drive sector and rotates freely on ball bearing about the torque tube. The drive sector is provided with a hole for engagement of a rigging pin.

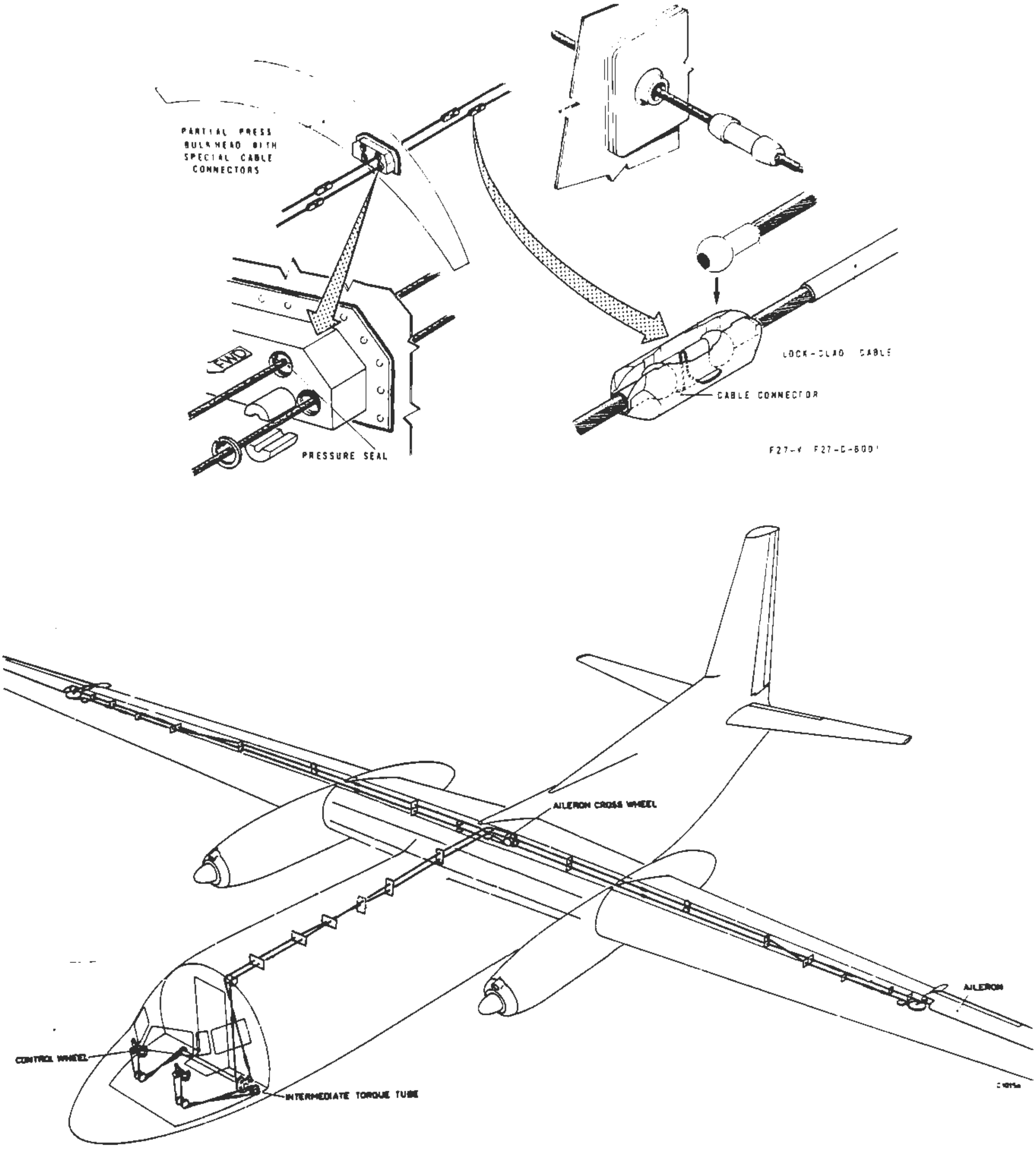
10.3 Aileron Crosswheel

The wheel is located to the rear of the centre wing rear spar at the left-hand side of the fuselage and is accessible through a door in the trailing edge when the flaps are extended. The cast wheel has three cable grooves. The fuselage cables from the cockpit run in the large diameter groove and the wing cables to the left-hand and right-hand ailerons run in the smaller diameter grooves. The wheel rotates on two ball bearings and is supported by a shaft which is attached to a bracket, bolted to the rear spar. A cable guard underneath the wheel prevents the cables from running off the drum. A lockplate is bolted to the wheel. When the wheel is in the neutral position and the gustlock is operated, the locking plunger engages the hole in the plate.

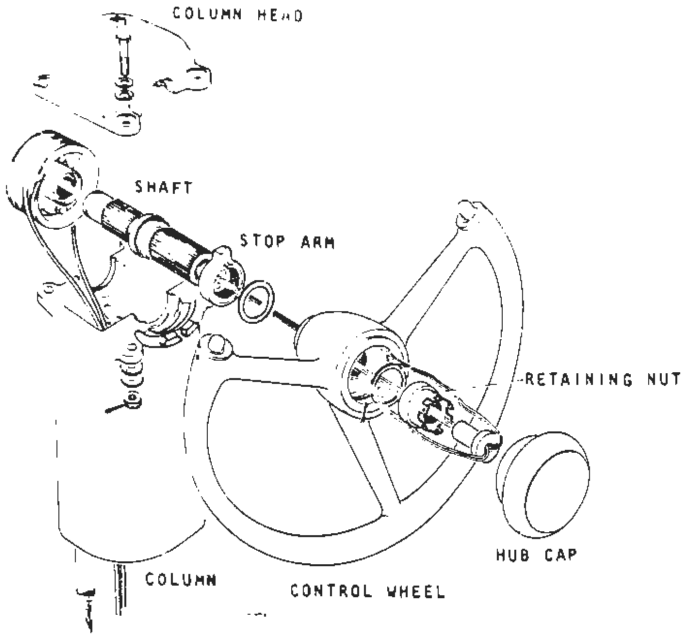
10.4 Differential Sectors

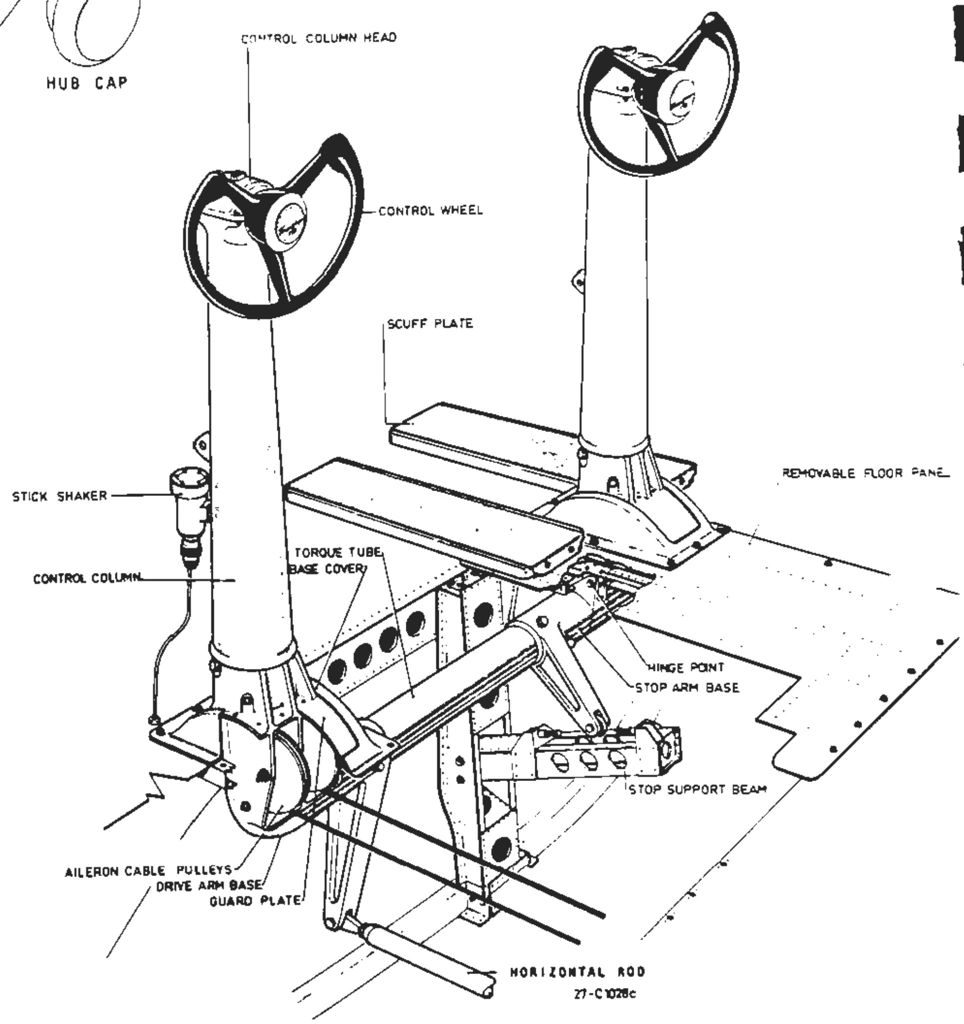
A differential sector is mounted to the rear of the rear spar in each outer wing. These sectors transfer the movement of the aileron cables to the ailerons through a control rod. Each sector rotates on two ball bearings around a shaft, which is supported by a bracket bolted to the spar caps. The bracket consists of two parts, bolted together, in order to facilitate removal and

installation. Holes are provided in each sector and bracket for installation of a rigging pin in the neutral position. The assembly is accessible through an access panel on the underside of the wing.
Due to the angular attachment of this push-pull rod in relation to the centre point of the sector, its linear travel is greater in one direction than in the opposite direction. This has the effect of giving the "up" aileron a greater "throw" or deflection than the "down" aileron, which is necessary because an equal deflection of the ailerons would result in an increase of drag on the wing with the "down" aileron (high wing) tending to force the nose of the aircraft into the wrong direction.

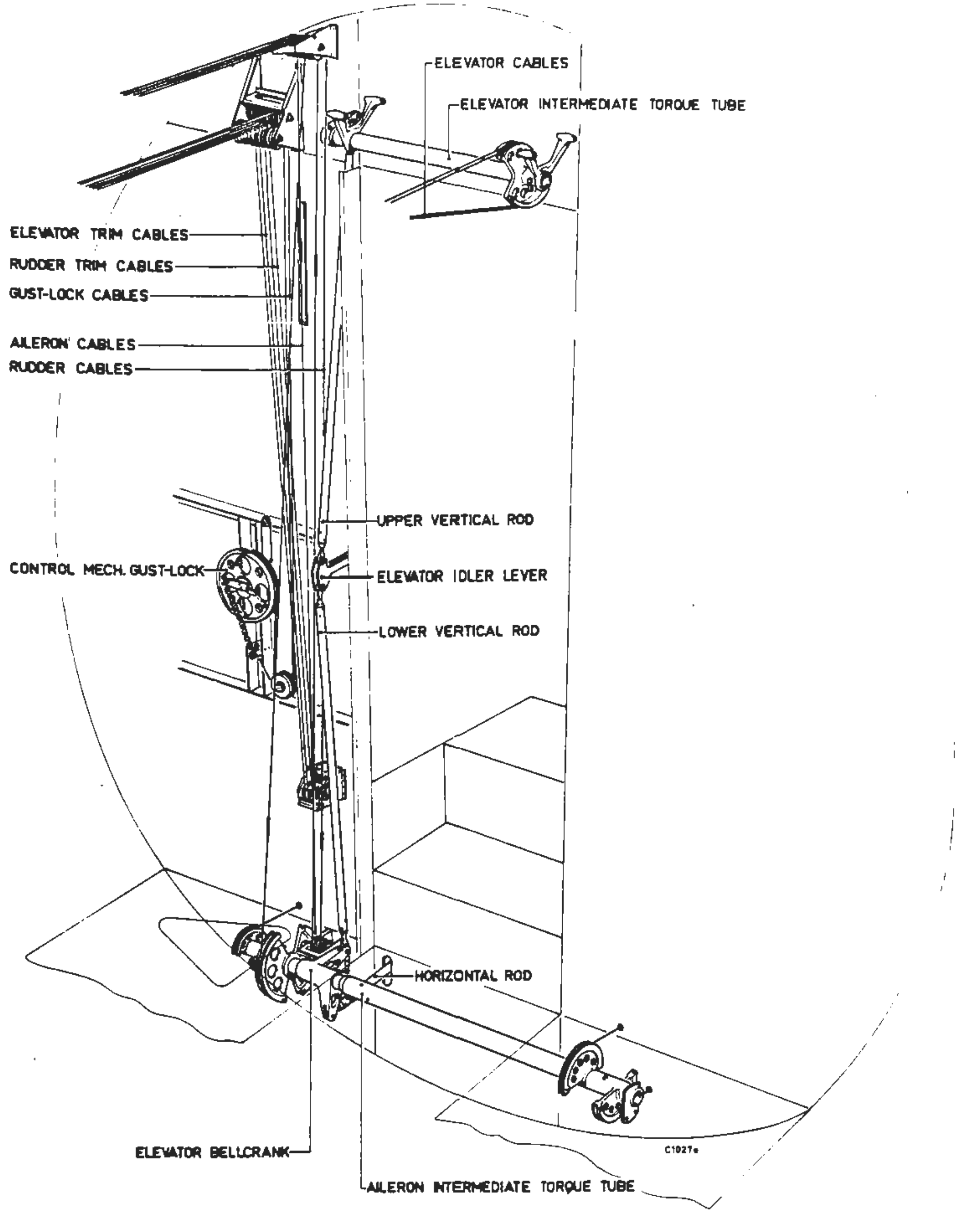


AILERON CONTROL SYSTEM

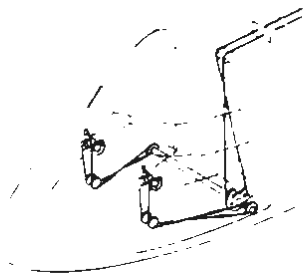


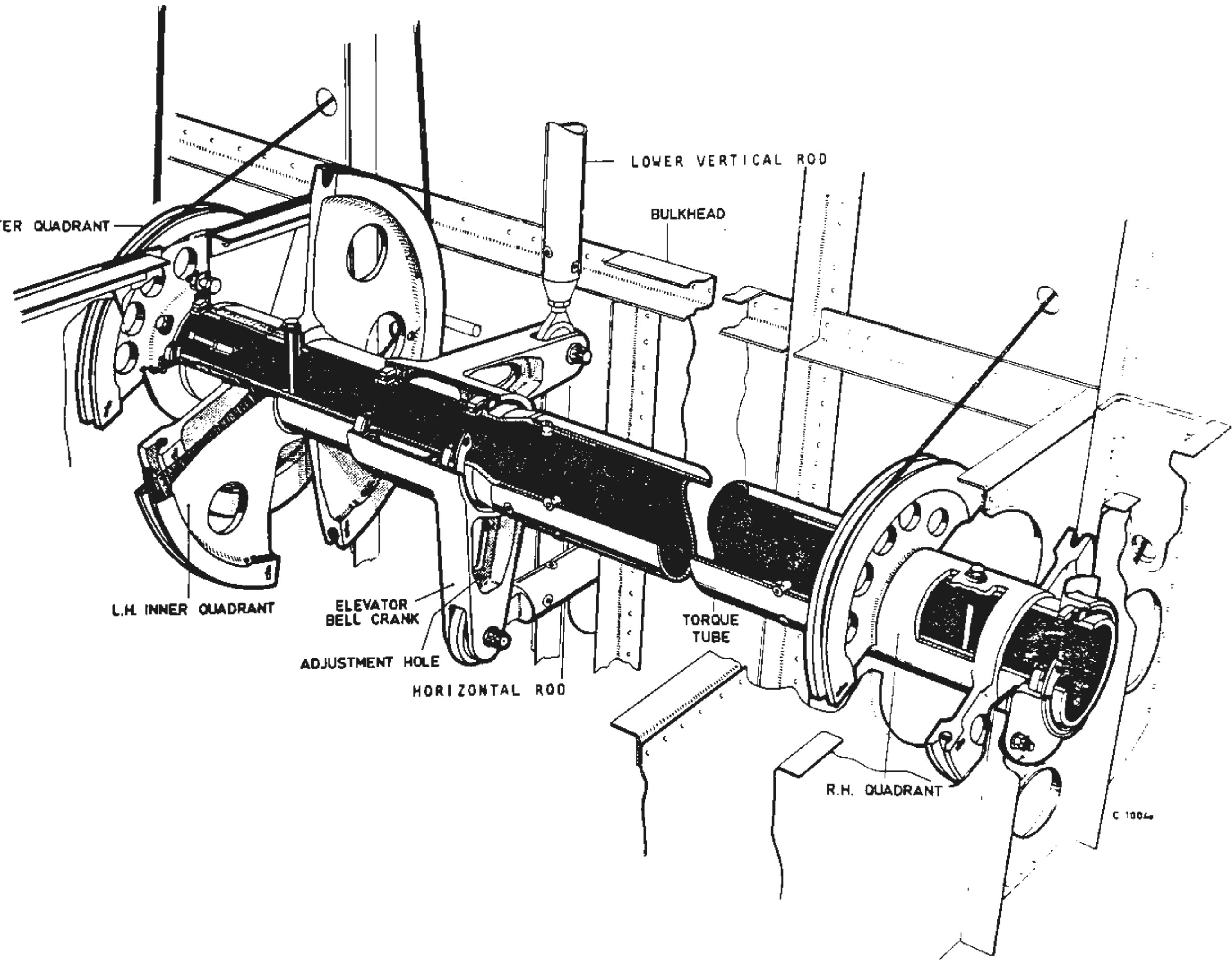


CONTROL COLUMNS INSTALLATION

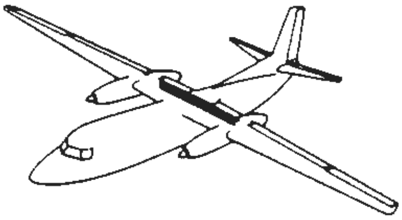


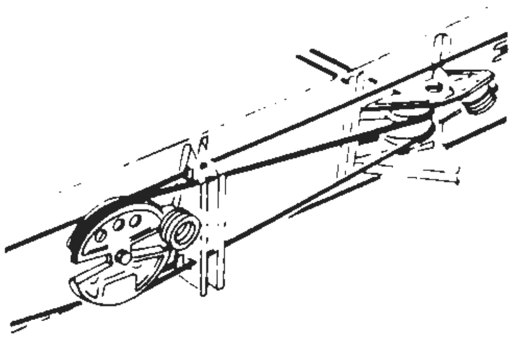
FLIGHT CONTROL SYSTEM INSTALLATION BEHIND COCKPIT REAR WALL

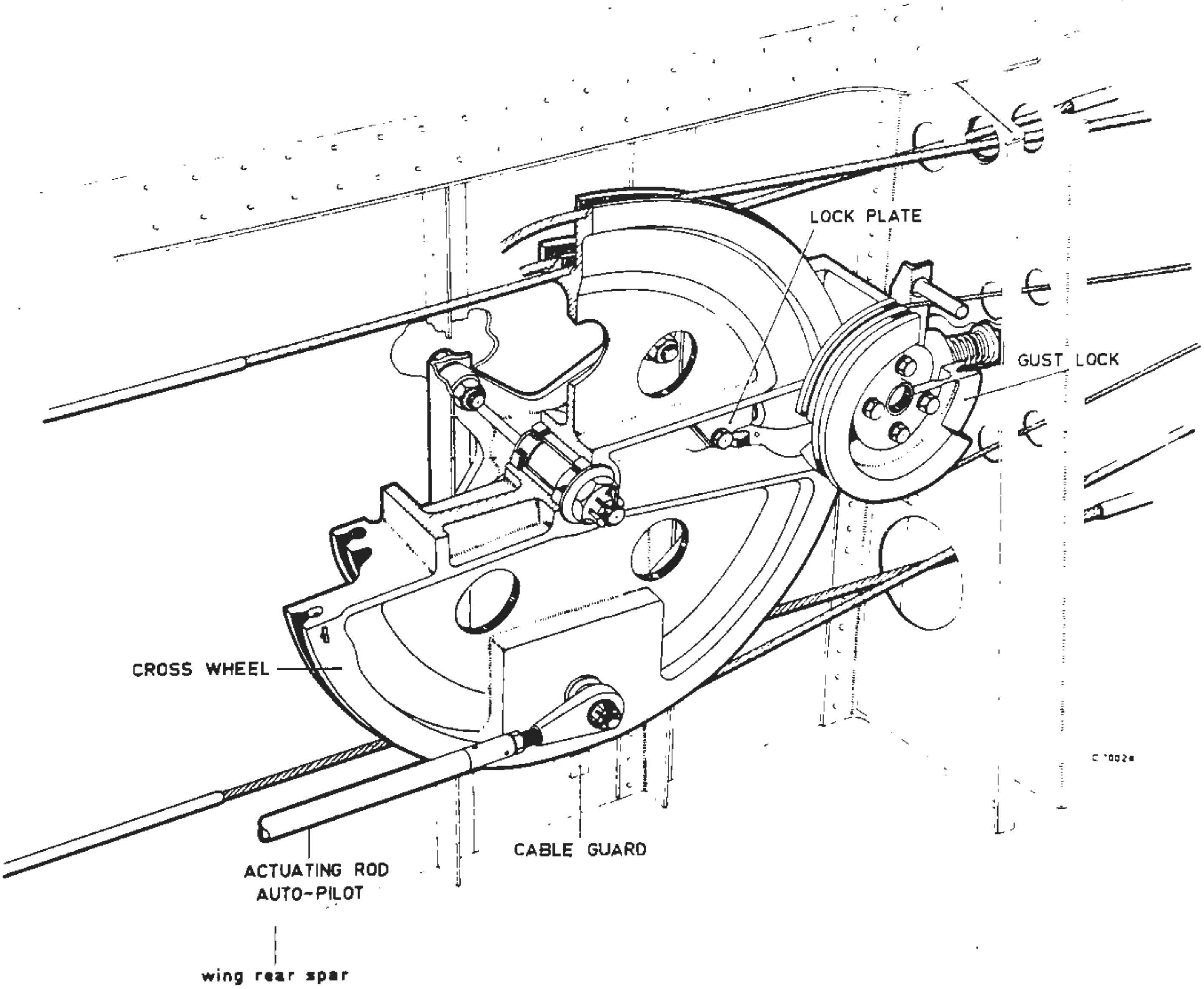




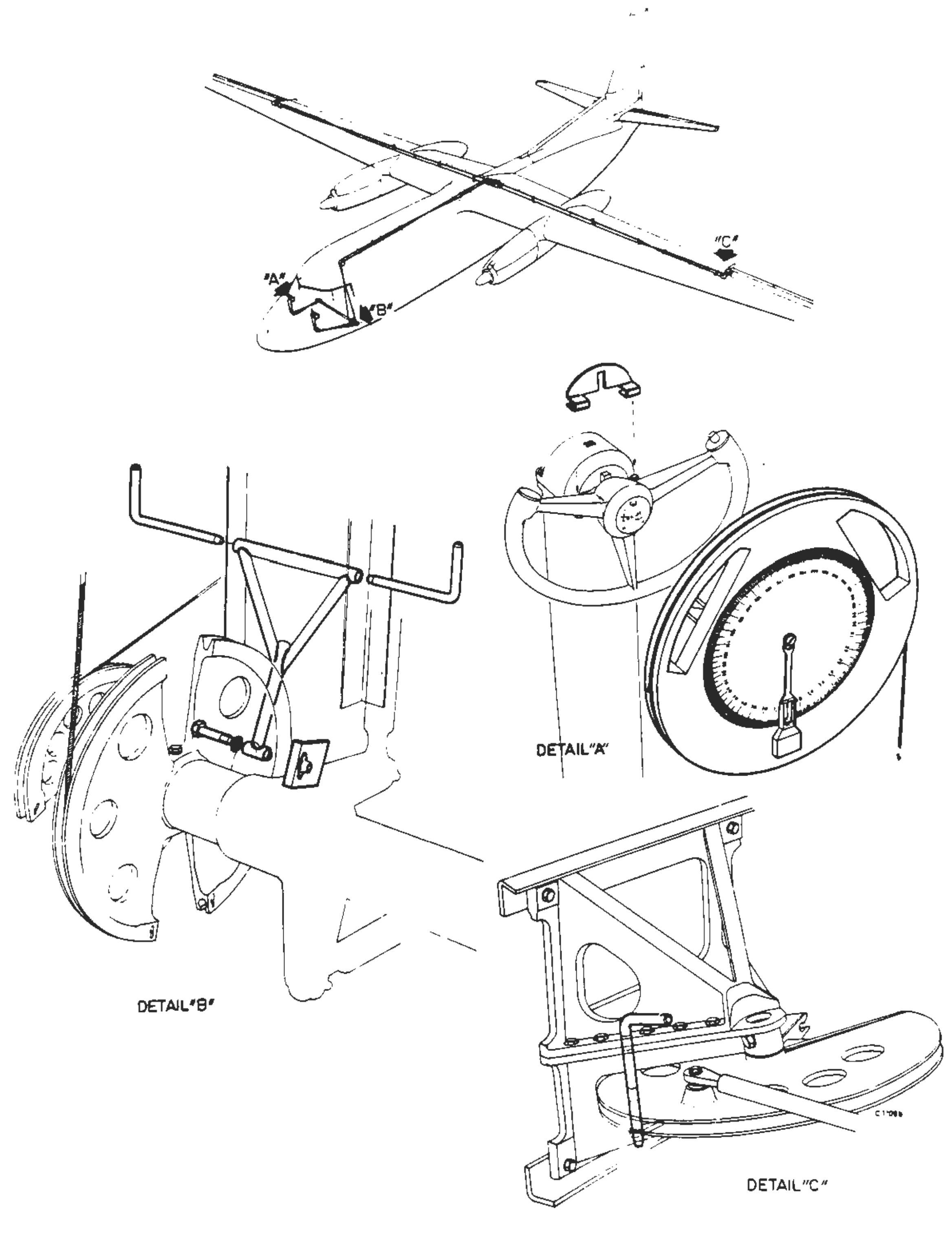
AILERON INTERMEDIATE TORQUE TUBE







AILERON CROSS-WHEEL



AILERON RIGGING

11.0 AILERON TABS CONTROL SYSTEM

Each aileron is provided with an inboard and an outboard tab. The inboard tabs are spring tabs and provide an aerodynamic boost, which reduces the control force to move the aileron. If a control force is applied, the spring tabs will operate only when an airload is acting on the aileron. The right-hand outboard tab is a trim/balance tab, linked to the wing structure in such a way that the movement of the aileron will cause the tab to move in opposite direction, thus reducing the control forces necessary for aileron operation. An electrically operated trim mechanism is incorporated in the linkage to the wing structure. The left-hand outboard tab is a balance tab.

11.1 Spring Tab Drive Mechanism

The spring tab is driven via a balance unit, located in the inboard side of the aileron and consisting of the balance lever, support shaft, torsion bar and housing. At the front, the balance lever is connected to the differential sector in the wing, and at the rear to the aileron spring tab by means of push-pull rods. The balance lever is fitted on the hollow support shaft, rotating in ball bearings in the housing. The housing is bolted to the aileron structure. A steel torsion bar, running inside the support shaft, is connected to the balance lever at the inboard side and to the housing at the outboard side by means of a tapered pin.

When no airload is acting on the aileron, the balance lever is held in the centre position by the torsion bar. However, when an airload offers resistance to aileron movement, the control force applied will twist the torsion bar which causes a deflection of the spring tab. The spring tab deflection is in opposite to aileron deflection, thus providing an aerodynamic boost which reduces the control force required to move the aileron. Spring tab deflection is proportional to the airload on the aileron, but is limited by the stop pin at the lower side of the balance lever.
The aileron movement is limited by two adjustable stops in the wing trailing edge.

11.2 Trim/Balance Tab Drive Mechanism

The tab is operated by a push-pull rod, driven by an idler lever, which is pivot-mounted at its lower end to one of the aileron hinge brackets below the aileron hinge line. The upper end of the idler lever is linked to the wing trailing edge through an electrically operated linear trim actuator.

11.3 Trim Control Panel

The trim control panel, installed on the pedestal, contains a selector switch unit and a trim position indicator. The selector switch unit is of the rotary type, with a gang of four microswitches, actuated in pairs by a camshaft and provided with a neutral position detent.

The selector knob is springloaded to the neutral position by means of a special spring, the legs of which embrace a fixed bolt on the panel and a crank attached to the switch camshaft. To prevent overtravel of the selector knob a stop bolt is provided which butts against the lower attachment screws of the knob.

The trim position indicator is basically a voltmeter. The pointer indicates the amount of trim applied. With the tab in its extreme position, the indicator reads "1".

11.4 Trim Actuator

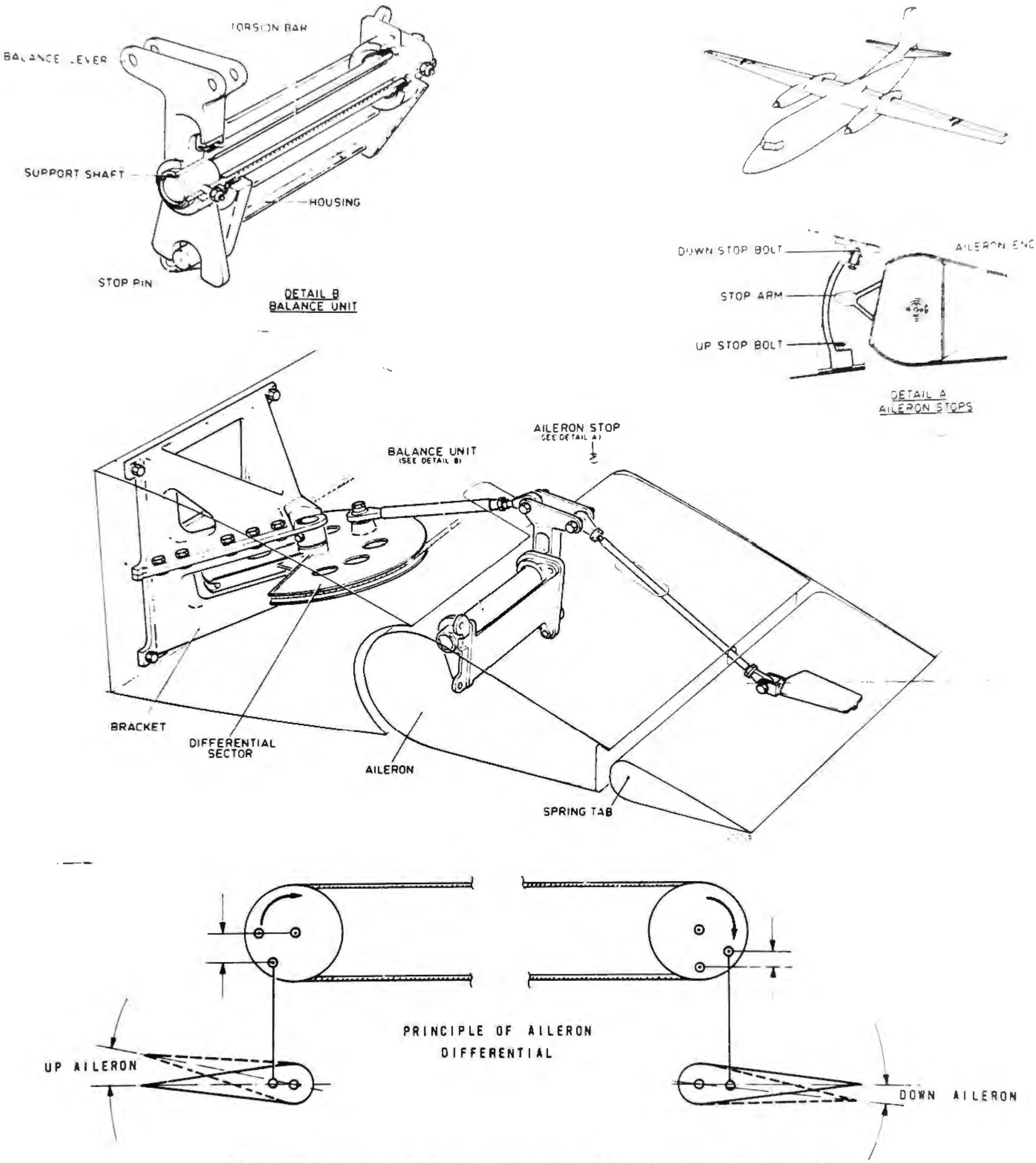
The actuator consists of a screwjack operated by a DC electric motor via a reduction gear train. The screwjack assembly comprises an externally threaded screw which turns within a jack nut tube. The housing of the screwjack contains preset limit switches, actuated by a follow-up nut, to restrict the tab travel. The DC motor incorporates an electro magnetic friction brake to provide immediate braking action. A potentiometer, driven by the screwjack, serves as a trim position transmitter.

11.5 Electrical Trim Circuit

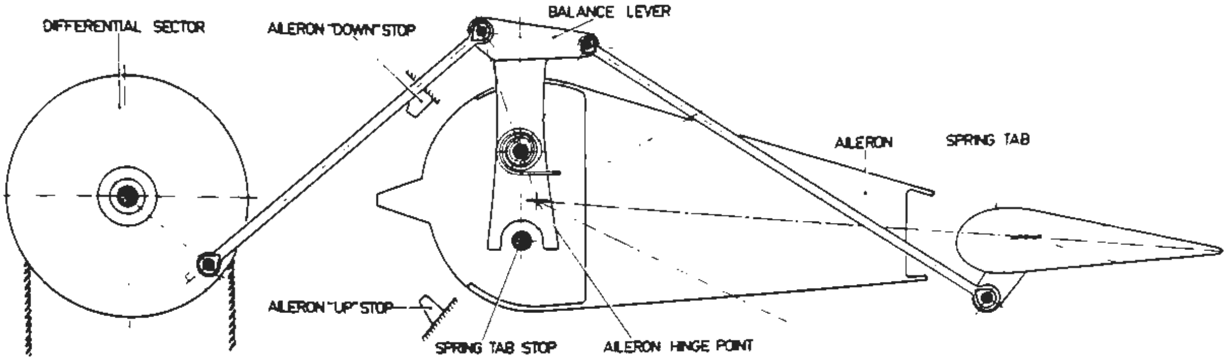
The three position trim selector switch unit on the pedestal incorporates four microswitches. When the selector knob is held in the STARBOARD WING DOWN position two microswitches are closed. This completes a circuit to the "extend" field of the motor.

The actuator commences to extend lowering the right-hand trim/balance tab. In the extreme position the limit switch switches off the motor. An electrical bridge indicating system is provided to give the pilot a visual indication of the amount of trim. The actuator incorporates a potentiometer, the moving contact of which is connected to an indicator. With the actuator in the midposition, the voltage output on both sides is equal and the indication reads zero. When the actuator is operated a voltage difference arises, causing a current flow through the instrument. The current will vary proportionally to the amount of trim applied.

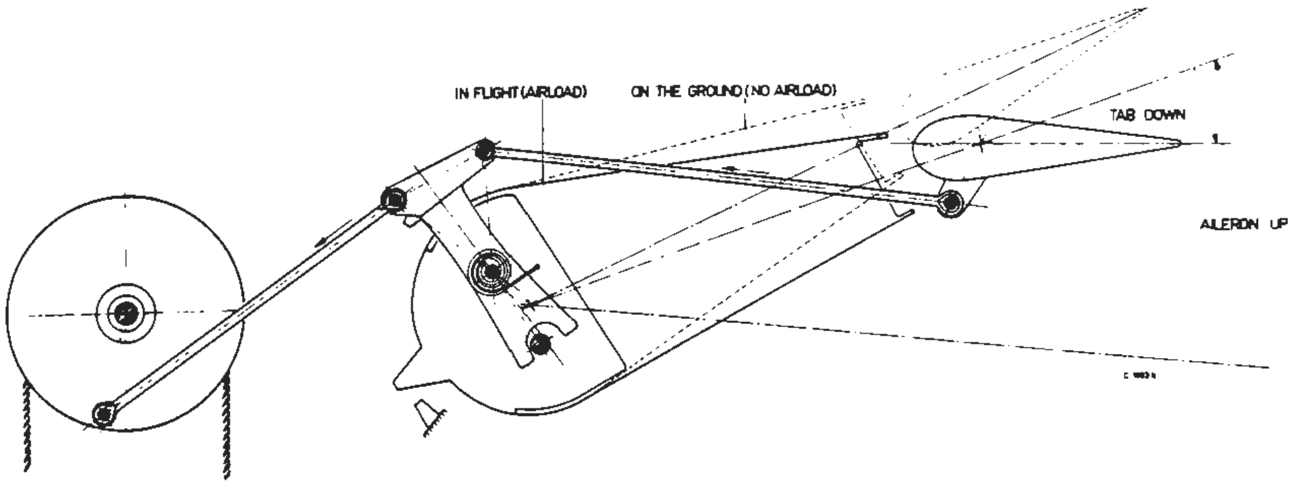
END



AILERON AND AILERON SPRING TAB DRIVE MECHANISM

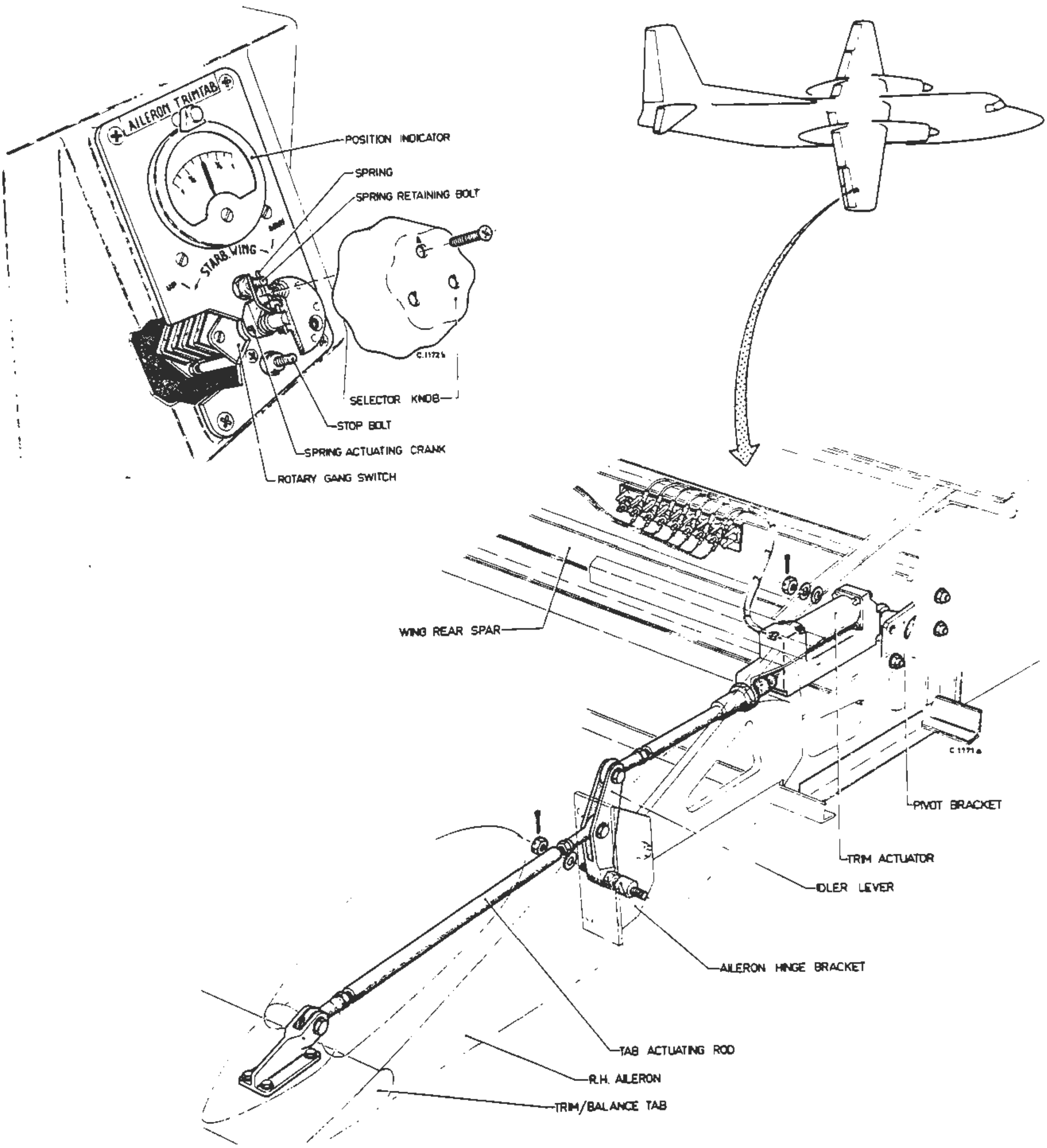


NEUTRAL POSITION
AND MAXIMUM STOP DEFLECTIONS

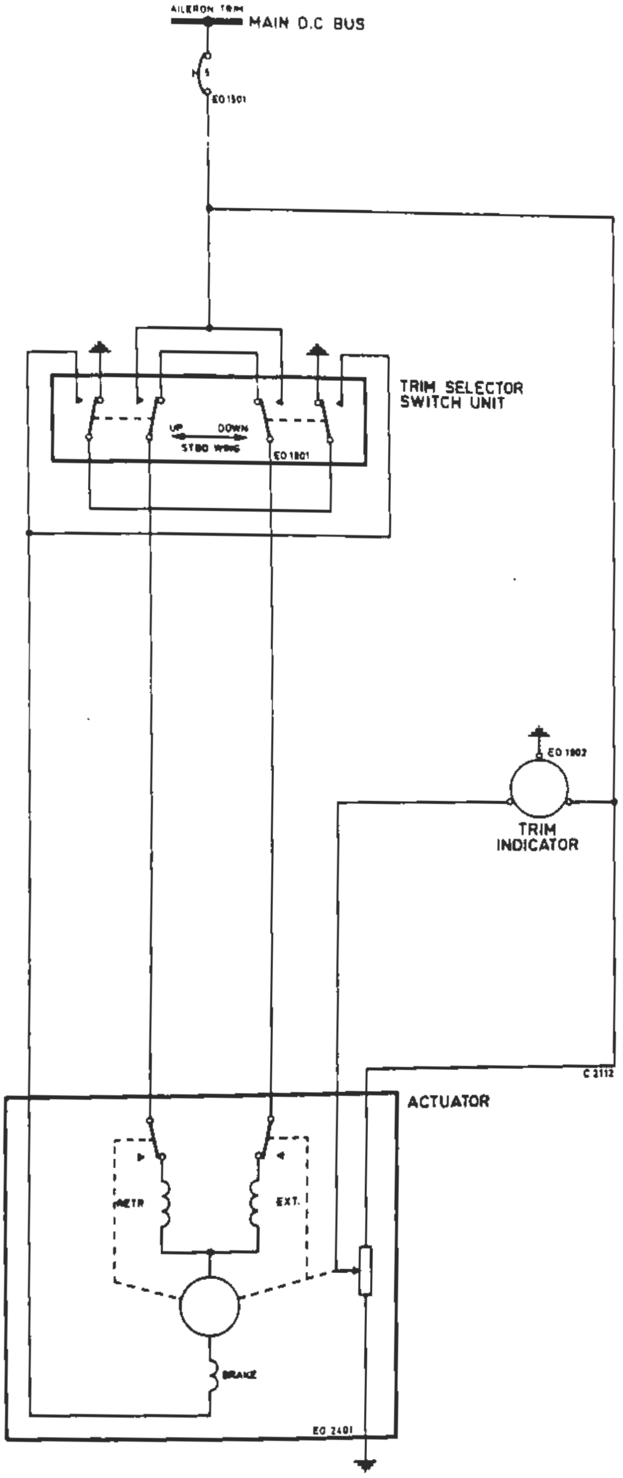


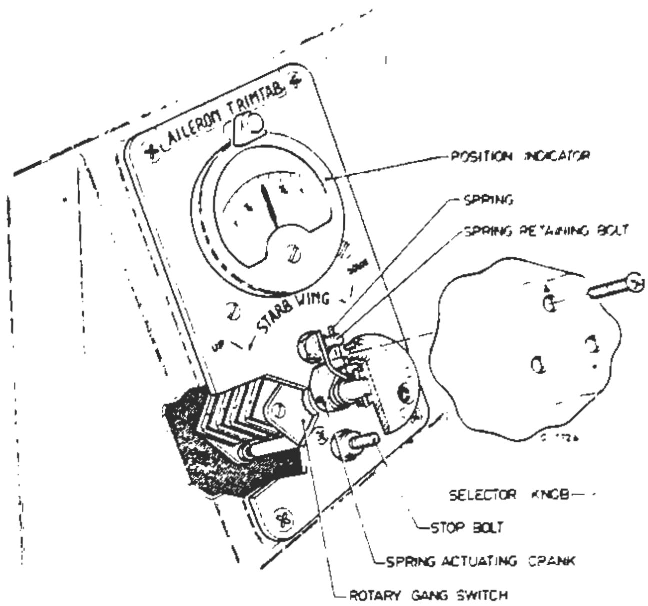
AILERON DEFLECTED UPWARDS

AILERON SPRING TAB DRIVE MECHANISM



AILERON TRIM/BALANCE TAB DRIVE MECHANISM





AILERON TRIM TAB CONTROL CIRCUIT

20.0 RUDDER CONTROL SYSTEM

The rudder is controlled by two sets of adjustable pedals. Movement of the pedals is transmitted to an intermediate torque tube under the cockpit floor. This tube synchronizes the movement of both sets of rudder pedals. A large drive sector, attached to the torque tube, transmits the movement via Lock-Clad cables to the quadrants on the tension regulator in the rear fuselage A drive arm attached to the regulator is connected to the rudder drive arm by a push-pull rod. A mechanically operated gustlock in front of the regulator locks the rudder in the neutral position.

20.1 Rudder Pedals

Each set of pedals is suspended from a support tube on either side of the pedestal under the instrument panel. The tube is attached to brackets on the pedestal and the cockpit side wall. Each rudder pedal pivots on two ball bearings and is provided with a lever, connected to a quadrant lever (worm gear sector) on the intermediate torque tube via an adjustable push-pull rod. A brake pedal is mounted on the lower side of each rudder pedal and pivots in two ball bearings. It is connected to the brake valve control system by a push-pull rod in such a manner that movement of the rudder pedals does not affect the brake control system. A scuff plate is installed on the floor below each rudder pedal.

20.2 Intermediate Torque Tube

The intermediate torque tube is located under the cockpit floor. It rotates on two ball bearings in brackets, bolted to longitudinal supports. A cast frame is bolted to each end of the torque tube outboard of its supporting brackets, to house the pedal adjustment mechanism. Movement of the push-pull rods from the rudder pedals is transmitted to the torque tube by the quadrant levers, incorporated in the pedal adjustment mechanism. A drive sector, bolted to the torque tube on the left-hand side, transmits the control movement via Lock-Clad cables to the rudder drive mechanism in the rear fuselage. Rudder control travel is limited by two adjustable stop bolts on the drive sector which abut against stops on the longitudinal support.

20.3 Pedal Adjustment Mechanism

Adjustment of the rudder pedals is obtained by changing the position of the quadrant levers on the intermediate torque tube. These levers are pivot-mounted to the cast frames at the ends of the torque tube, but are held in a fixed position by a toothed quadrant on the levers, which engage a vertical worm-wheel mounted in the same frame. Rotation of the worm-wheel causes the quadrant levers to move up or down. This movement is transmitted via the push-pull rods to the rudder pedals, which consequently move forward or aft. The movement is limited by a stop pin in the slots of the lever quadrants. The worm-wheel is operated by a crank under the instrument panel via a drive shaft assembly. The drive shafts are interconnected by universal joints and the assembly is supported by two brackets, each provided with two ball bearings. The lower drive shaft is of telescopic design to allow for worm-wheel movement caused by rotation of the intermediate torque tube.

20.4 Rudder Drive Mechanism

The rudder drive mechanism in the rear fuselage consists of the cable tension regulator, a stop assembly and a push-pull rod. The cables coming from the front fuselage are anchored in grooves to the quadrants of the rudder tension regulator. This regulator is installed on the same support as used for the elevator tension regulator. For description, operation and installation of the tension regulator refer to the elevator control system. An adjustable

push-pull rod connects the drive arm on the tension regulator to the rudder drive arm. Rudder deflections are limited by stops in the same manner as for the elevators. The gustlock for the rudder is located in front of the tension regulator assembly. When operated, the locking plunger engages a hole in a track on the tension regulator and locks the rudder in the neutral position.

21.0 RUDDER TABS CONTROL SYSTEM

The rudder is provided with a balance tab and a trim tab. The balance tab is installed below the trim tab and provides an aerodynamic boost, reducing the control force needed to move the rudder. Balance tab movement is proportional to rudder movement. A balance lever and an adjustable push-pull rod are incorporated in the balance tab drive system. A mechanically operated trim tab is installed above the balance tab. The trim tab is operated through a knob on the cockpit pedestal. A cable system transmits the control movement to the trim tab drive mechanism located in the rudder.

21.1 Trim Tab Drive Mechanism

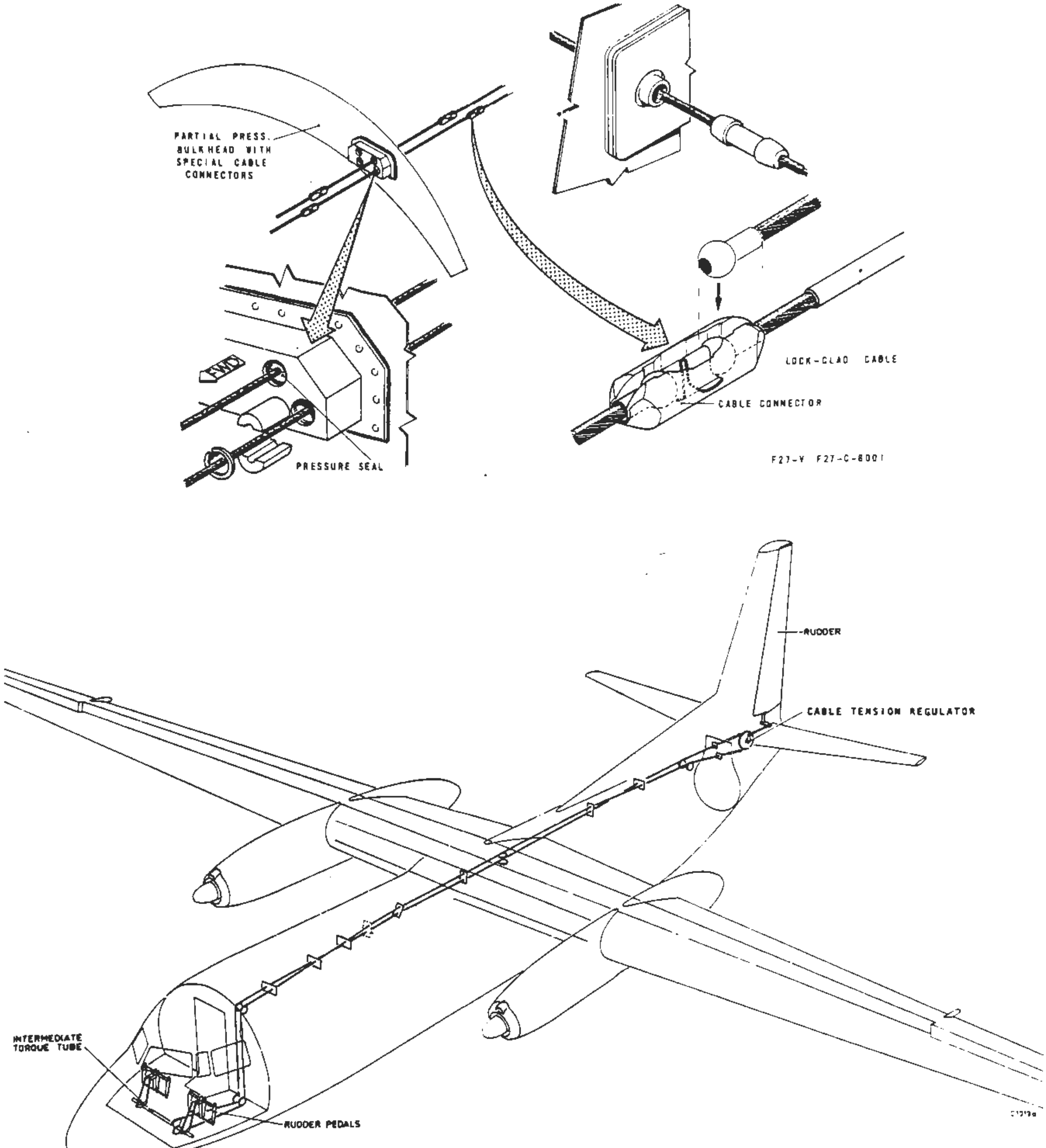
The drive mechanism of the rudder trim tab is located between the two rudder ribs and consists of a cable drum assembly, a chain with tensioning device and a screwjack. The drum shaft and sprocket assembly is mounted in two bearing blocks. The grooved cable drum is riveted to a flange on the shaft.

Cable drum movement is transmitted to the screwjack through the sprocket and chain assembly. The screwjack is the same type used in all cable operated trim systems. The screwjack consists of a body, a right-hand acme screw shaft and an actuating shaft. A trim tab actuating rod is installed between the screwjack and the trim tab.

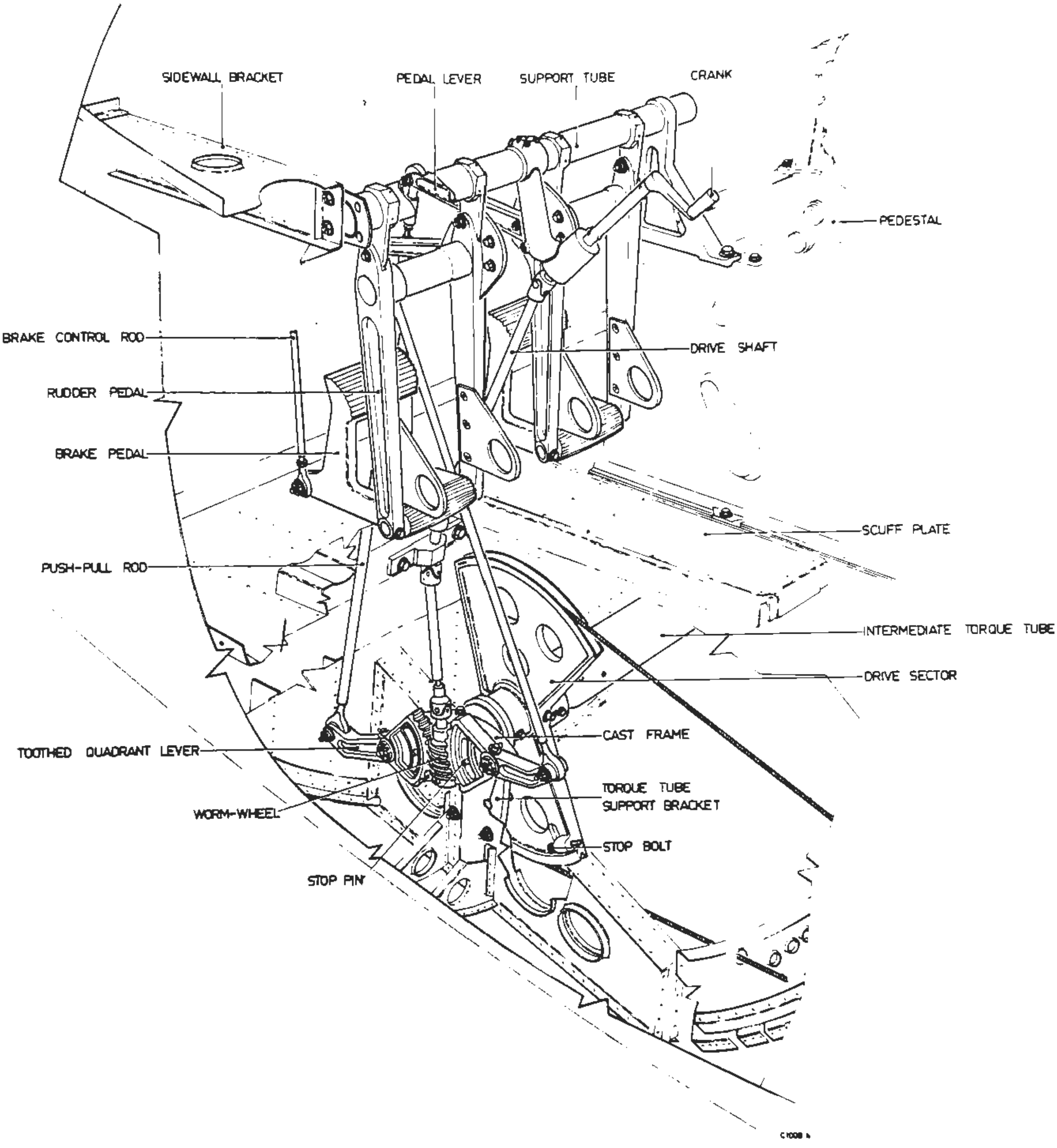
21.2 Balance Tab Drive Mechanism

The balance tab is actuated by an adjustable push-pull rod, connected to the short arm of an L-shaped balance lever. The forward end of this lever is attached to a lug on the vertical stabilizer structure. The rear end is pivot-mounted to a bracket on the rudder main spar. This point is situated on the rudder hinge line, so movement of the rudder does not affect the position of the lever but causes the rod to deflect the tab in opposite direction, reducing the control force necessary to operate the rudder.

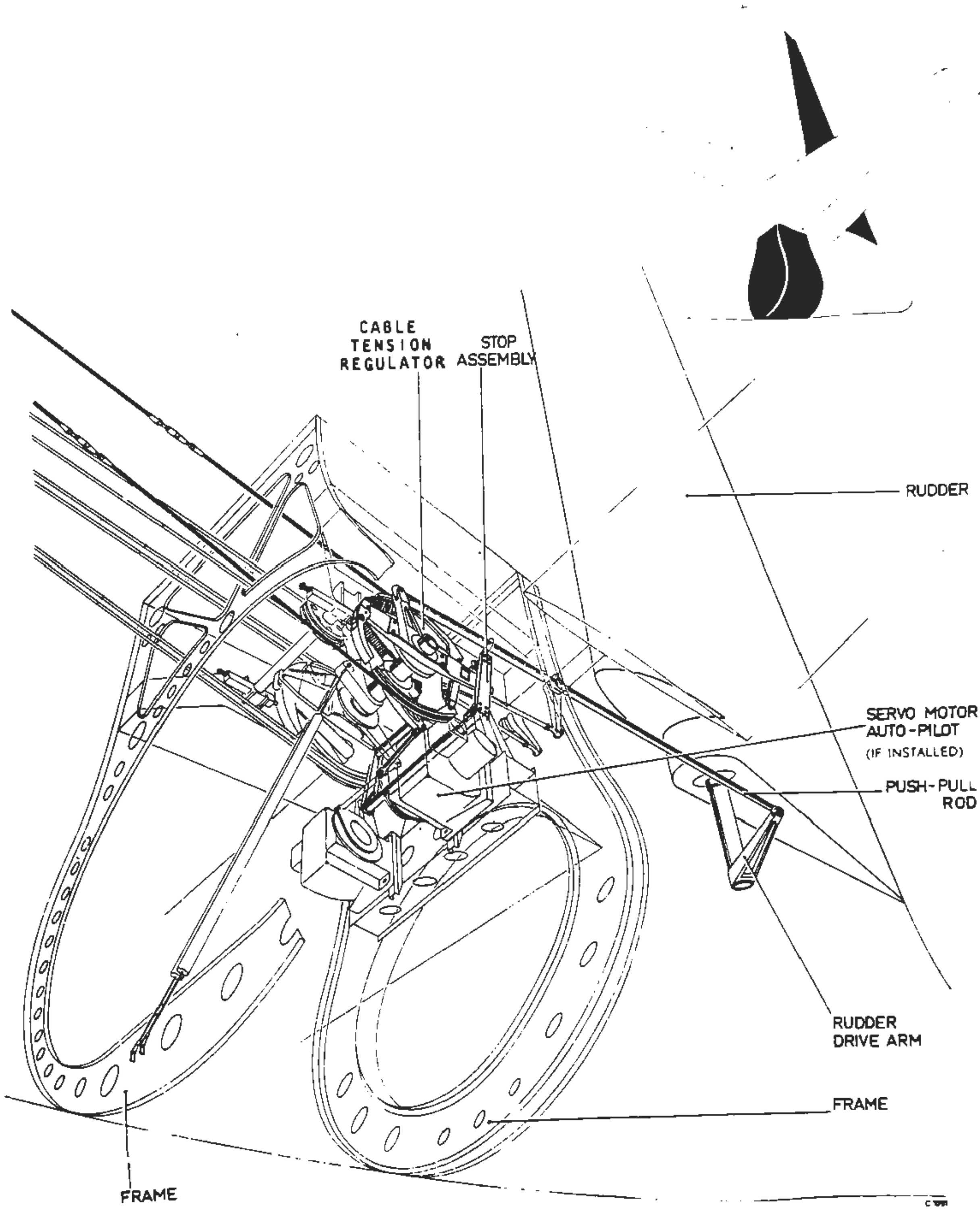
END



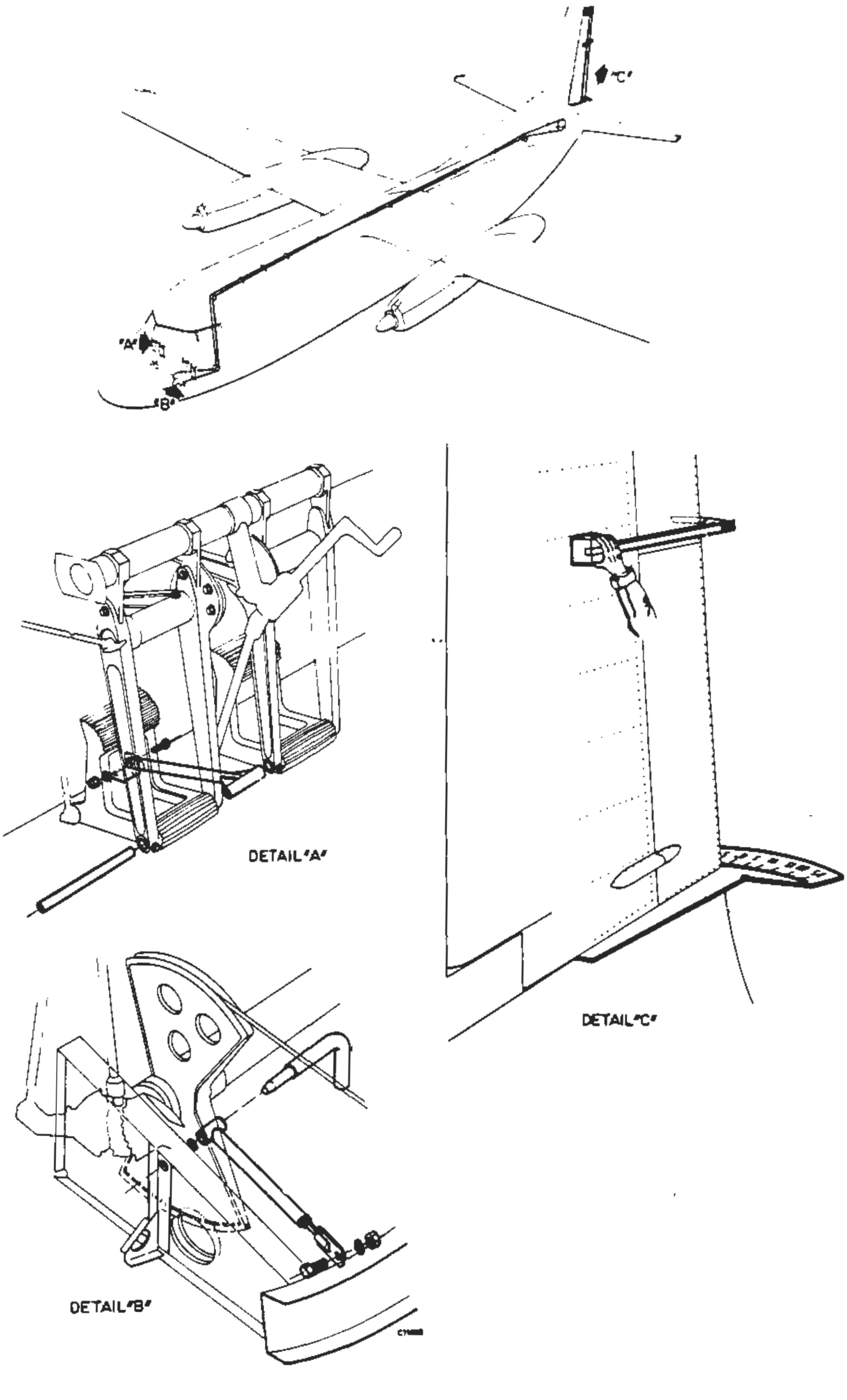
RUBBER CONTROL SYSTEM



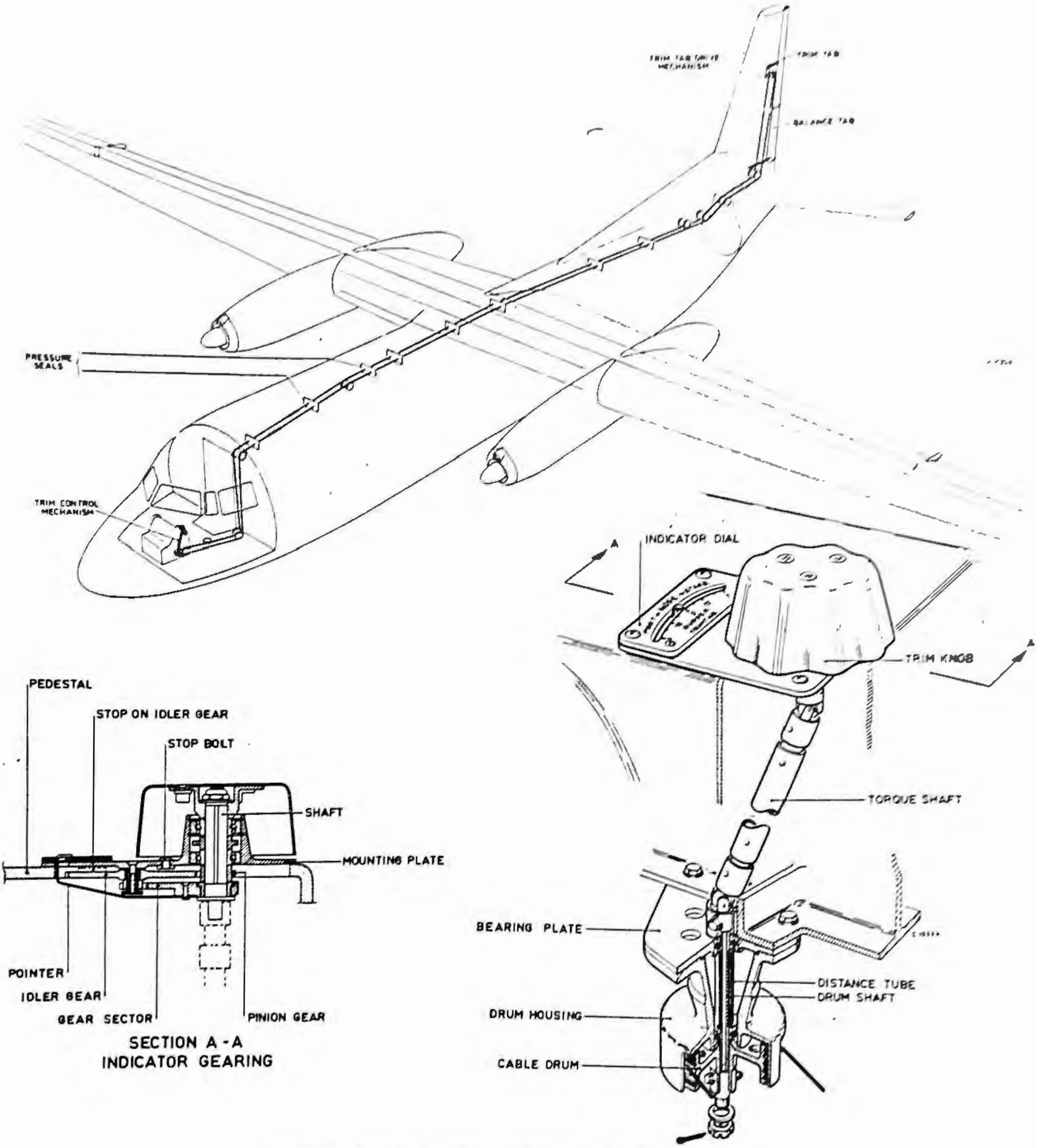
RUDDER PEDALS AND INTERMEDIATE TORQUE TUBE



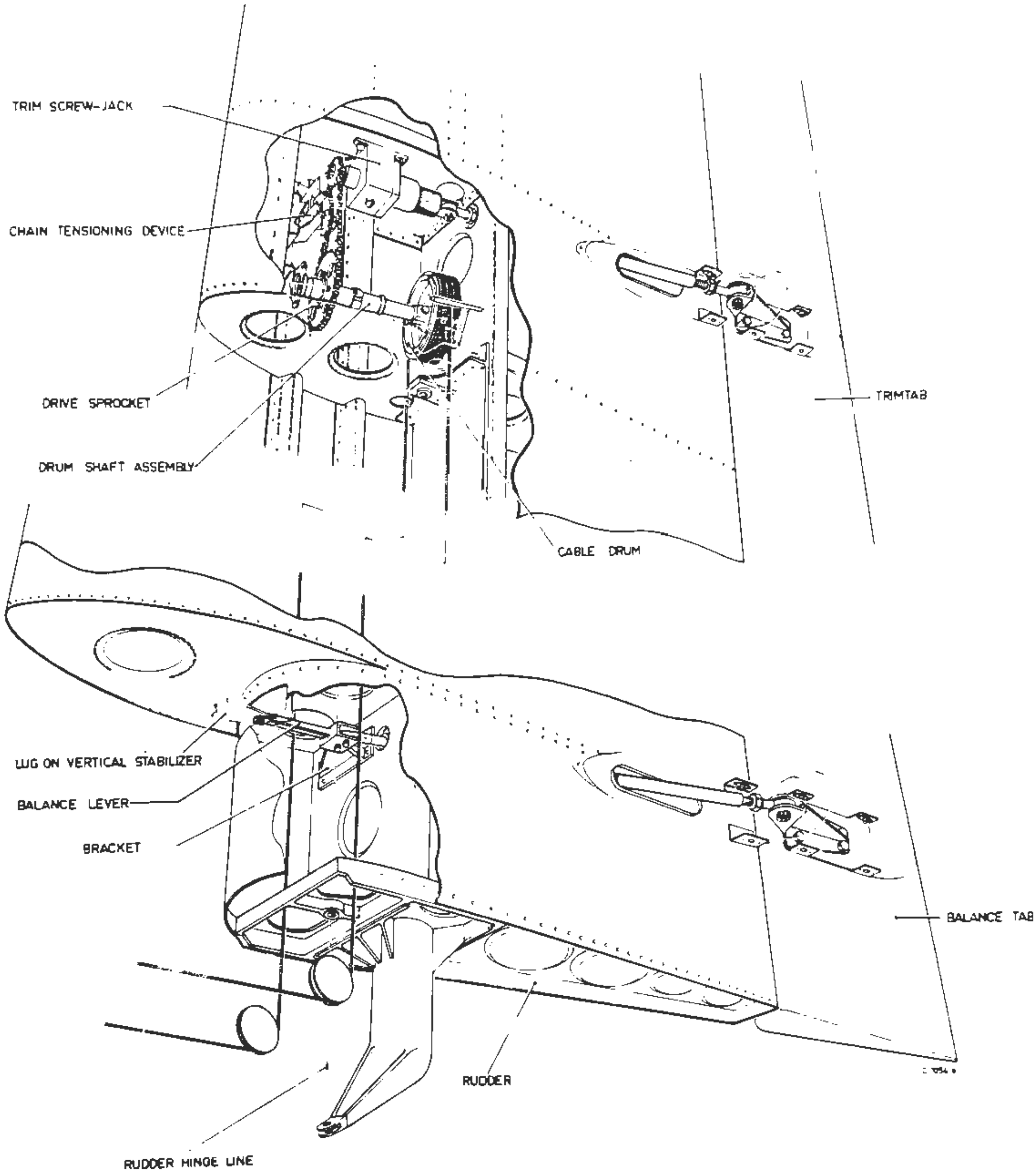
RUDDER DRIVE MECHANISM



RUDDER RIGGING



RUDDER TRIM TAB CONTROL MECHANISM



RUDDER TABS DRIVE MECHANISMS

30.0 ELEVATOR CONTROL SYSTEM

The elevators are operated by control column movement via push-pull rods and a conventional cable system. Push-pull rods transmit control column movement to an elevator intermediate torque tube. A dual Lock-Clad cable system runs from a drive sector on the intermediate torque tube to a cable tension regulator in the rear fuselage. A drive arm on the cable tension regulator operates the left-hand and right-hand elevator via push-pull rods. To improve the "feel" of the elevator control system a bungee is connected to the drive arm on the regulator. The spring tension of the bungee tends to move the elevator to the down position. A mechanically operated gustlock, acting on the cable tension regulator, is provided to lock the elevator in the down position.

30.1 Control Columns

Two control columns, rigidly interconnected by a torque tube, are provided in the cockpit. Each control column consists of three castings: the head, (supporting the aileron control wheel), the column and the base. The left-hand and right-hand control column are bolted to the drive arm base. Both the drive arm base and the stop arm base are bolted to the torque tube and incorporate a hinge point. The control column unit pivots in two ball bearings housed in brackets on the removable floor panel. Control column movement is limited by a lever on the right-hand base, which butts against adjustable stop bolts on a support beam below the cockpit floor. The drive arm fitted to the left-hand base transmits control movement to the elevator intermediate torque tube via a horizontal and a vertical linkage. To improve stall warning a stick shaker is provided on the left-hand column.

30.2 Horizontal and Vertical Linkage

A horizontally mounted, adjustable push-pull rod transmits control movement to a bellcrank. This bellcrank is supported on two ball bearings on the aileron intermediate torque tube; its movement is independent of torque tube movement. Two vertically mounted, adjustable push-pull rods, and an idler lever interconnect the bellcrank and a drive arm on the elevator intermediate torque tube. The control rods and the idler lever are located in the pneumatic compartment.

30.3 Elevator Intermediate Torque Tube

The elevator intermediate torque tube rotates in two ball bearings and is supported by two brackets located above the cockpit entrance just behind Sta. 3100. The vertical linkage is attached to a drive arm on the left-hand side of the torque tube. Dual Lock-Clad cables are connected to a two grooved drive sector, bolted to the right-hand side of the torque tube.

30.4 Cable Tension Regulator

The dual cable system, starting at the elevator intermediate torque tube, terminates on a cable tension regulator assembly, located in the rear fuselage. The cable tension regulator assembly consists of two identical units, one used in the elevator control system, the other in the rudder control system. Both units are mounted on a common support tube and maintain a preselected cable tension irrespective of thermal expansion or structural deflections. Basically each regulator consists of an upper and a lower cable quadrant, hinged to a drive arm assembly.

A stop-block limiting the elevator travel and a gustlock track are bolted to the tension regulator. A pointer and temperature scale are provided for rigging purposes.

Operation

Compression springs are installed between a frame on the drive arm assembly and the upper and lower quadrant. Once the compression force of the springs has been adjusted, any change in cable tension will be compensated by a swinging motion of the quadrants about their axis, paying out or taking in cable as necessary to restore the preselected cable tension. When a control force is applied, regulating action is eliminated by the brake assembly installed between the upper and lower quadrants.

30.5 Brake Assembly

The function of the brake assembly is to rigidly interconnect the upper and lower quadrant whenever an unequal load is applied to "up" or "down" cables. The brake assembly has a rotating bolt with opposing (high lead) threaded ends and forked nuts which are attached to the quadrants. The forked nuts slide in the barrels, which are joined with a coupling and secured with two lock-nuts. Slots in the square coupling ride in the horizontal brake guides on the side plates of the regulator. In the centre of the rotating bolt, a brake disc is located halfway between two stationary, hardened, friction washers, which are clamped between a spacer and the two barrels. When cable tensions vary due to temperature effects, the change is equally shared between both cables. The quadrants of the cable tension regulator are allowed to move away from, or towards each other, thereby freely spinning the brake bolt and allowing the forked nuts to slide within the barrels. When a control load is applied, the tension in the cables is unequal, thereby resulting in unequal movement of the quadrants. In this case the brake bolt moves only until the the brake disc contacts one of the friction washers. Rotation of the rotating bolt, and sliding action of the forked nuts are thereby stopped. The brake assembly will then virtually act as a strut, rigidly interconnecting the two quadrants.

NOTE: Always insert hardwood blocks between the regulator quadrants and side plates before relieving any cable tension in the system.

Functional Check of Tension Regulator

With the elevators in the "DOWN" position, engage the gustlock and apply an alternating force to the control column ("Pull and Push"). Check that the regulator is not compensating, which ensures that the regulator brake is functioning satisfactorily i.e. that the brake does not slip when a control load is applied.

Linkage between Tension Regulator and Elevator

Two push-pull rods are installed between the drive arm of the cable tension regulator and the elevators, one for the right-hand elevator and one for the left-hand elevator. These push-pull rods are adjustable near the tension regulator.

Elevator Stops

The elevator stop assembly consists of an upper and a lower tube, mounted between two vertical profiles, just aft of the cable tension regulator assembly. Adjustable stop bolts are installed on the upper and lower tube. A stop block, bolted between the regulator side plates, moves between the stop bolts.

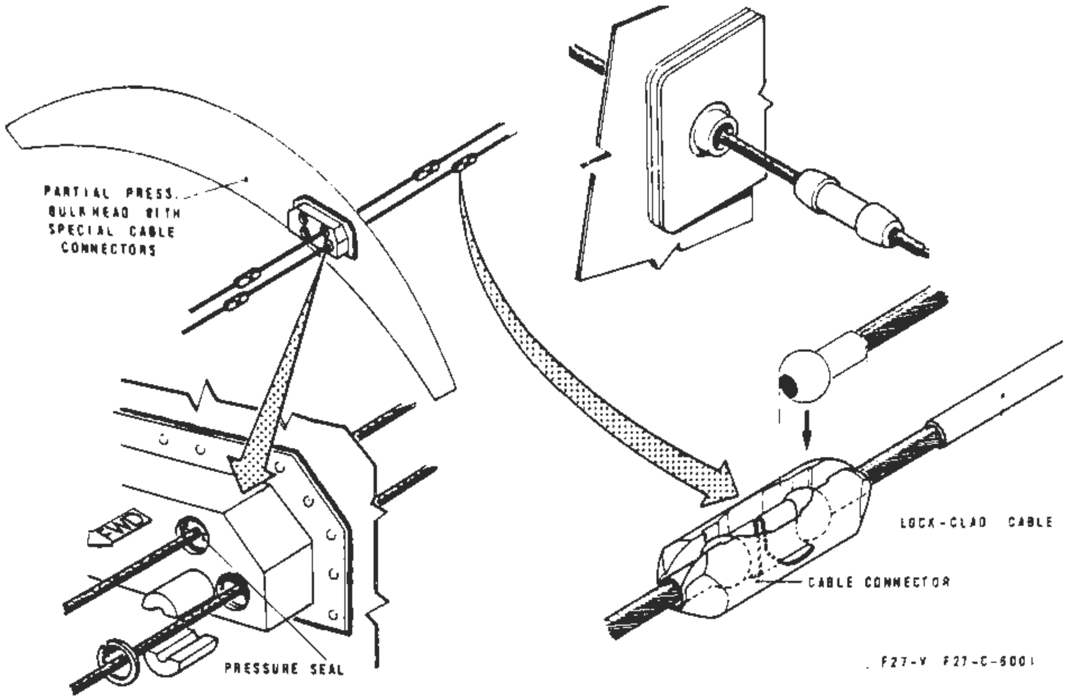
Elevator Bungee

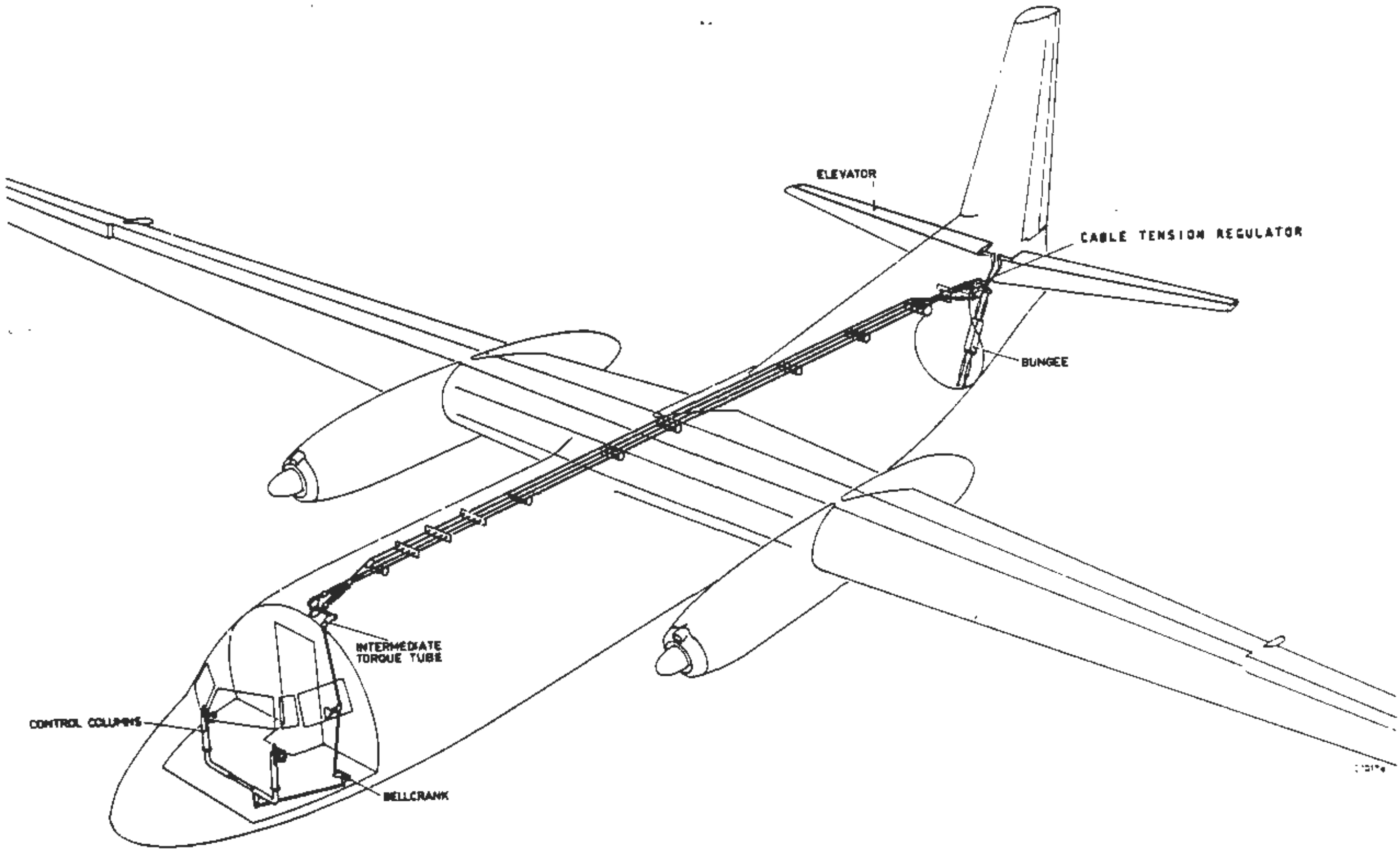
The elevator bungee consists of a dual spring assembly, each spring being enclosed by a shroud tube. Cables connect the upper end of the bungee to the drive arm of the cable tension regulator and the lower end to a platform on the fuselage bottom structure. Turnbuckles are provided on the cables to obtain the required spring tension.

31.0 ELEVATOR TAB CONTROL SYSTEM

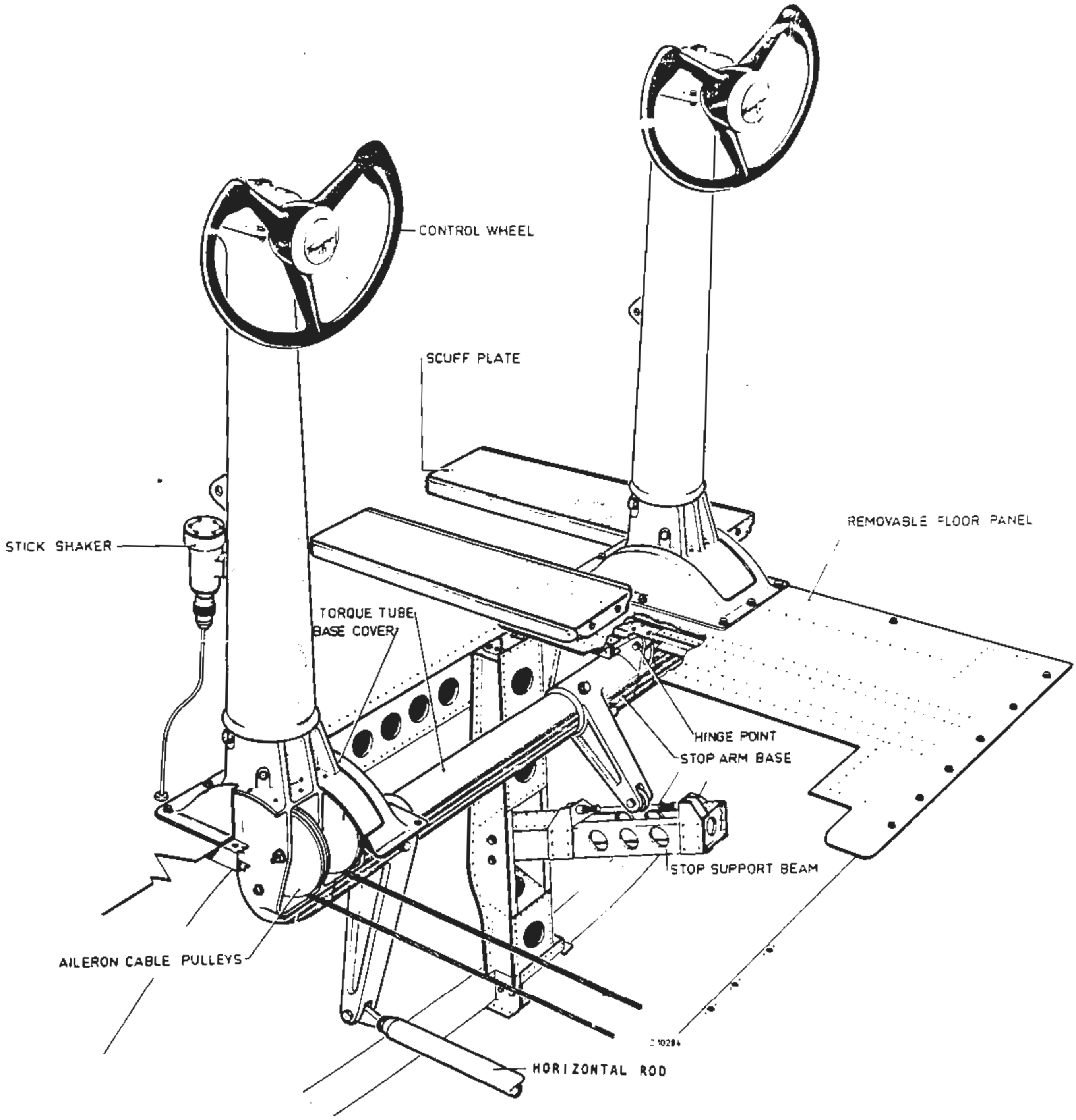
The left-hand elevator is provided with a trim tab which is controlled by trim wheels on each side of the pedestal. The wheels are mounted on a common shaft which actuates a cable drum via a chain. The drum in turn operates the cable system extending aft to the trim drive mechanism in the elevator. The drive mechanism consists of a drum and a screwjack, interconnected by a chain. The screwjack actuates the tab by means of a push-pull rod. Rotation of the control wheel in forward direction raises the trim tab and causes a "nose down" movement of the aircraft. The amount of elevator trim is indicated on a dial near each control wheel. A pinion gear is installed on each shaft end and drives an idler gear unit, which in turn drives a gear to which a pointer is attached. The pointer indicates the amount of elevator trim on the dial. A stop mechanism limits the rotation of the control wheel to about one turn from neutral in the forward and aft directions.
The screwjack and cable drum are installed inside the left-hand elevator on the elevator hinge line, that is why the elevator movement does not affect the trim drive mechanism.

END

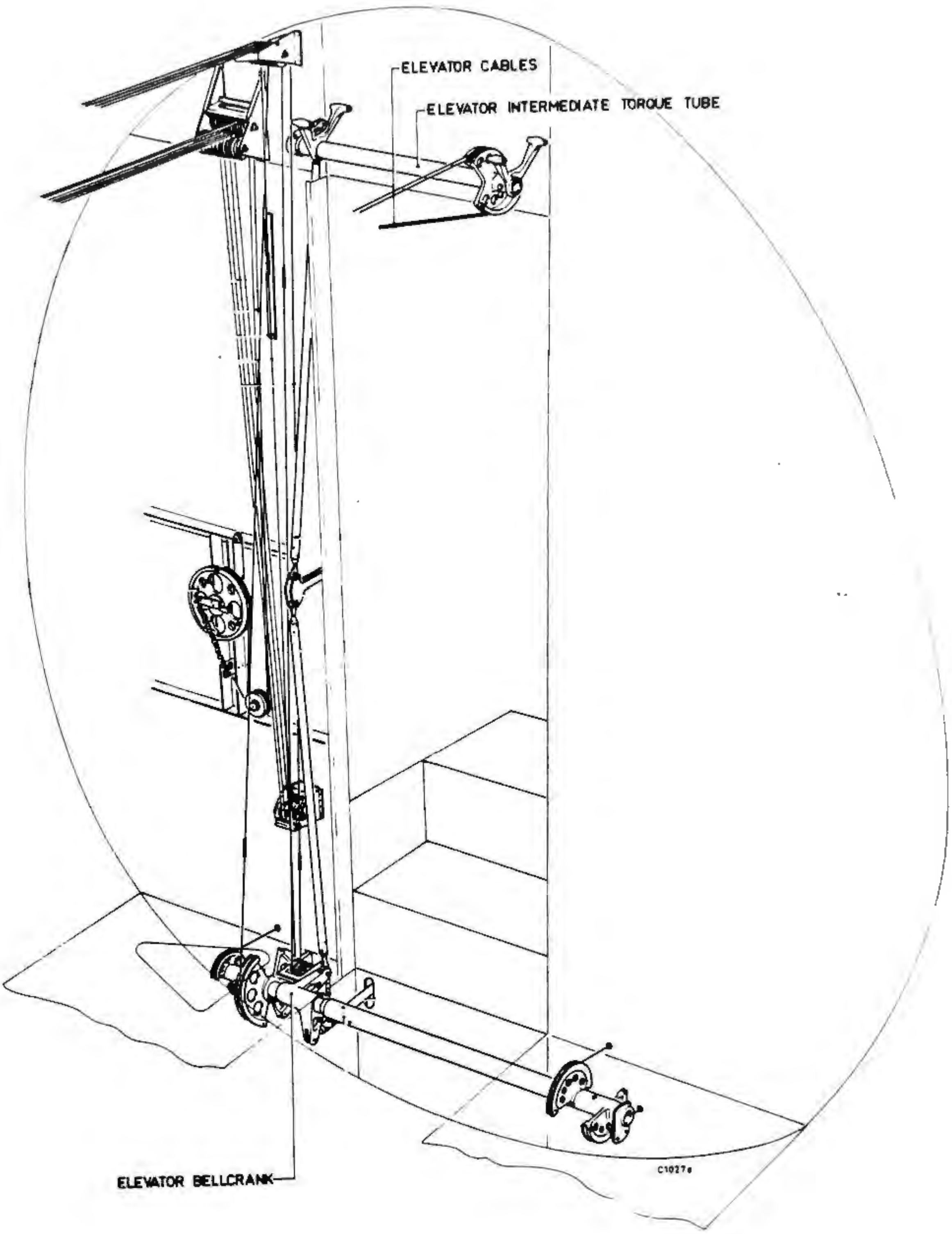




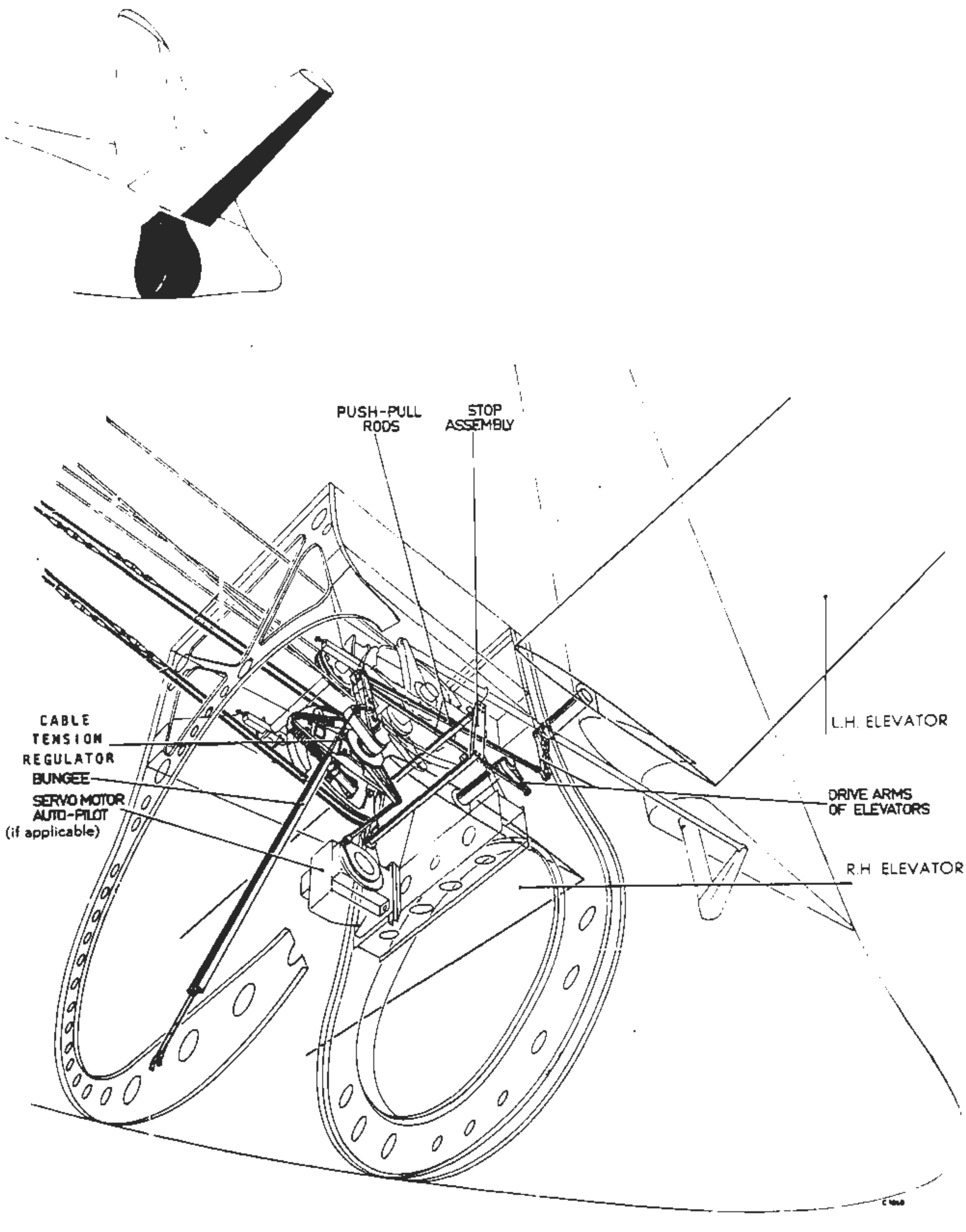
ELEVATOR CONTROL SYSTEM



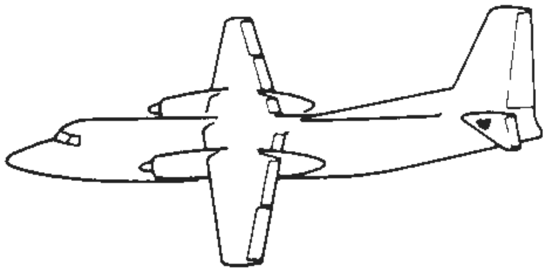
CONTROL COLUMNS INSTALLATION

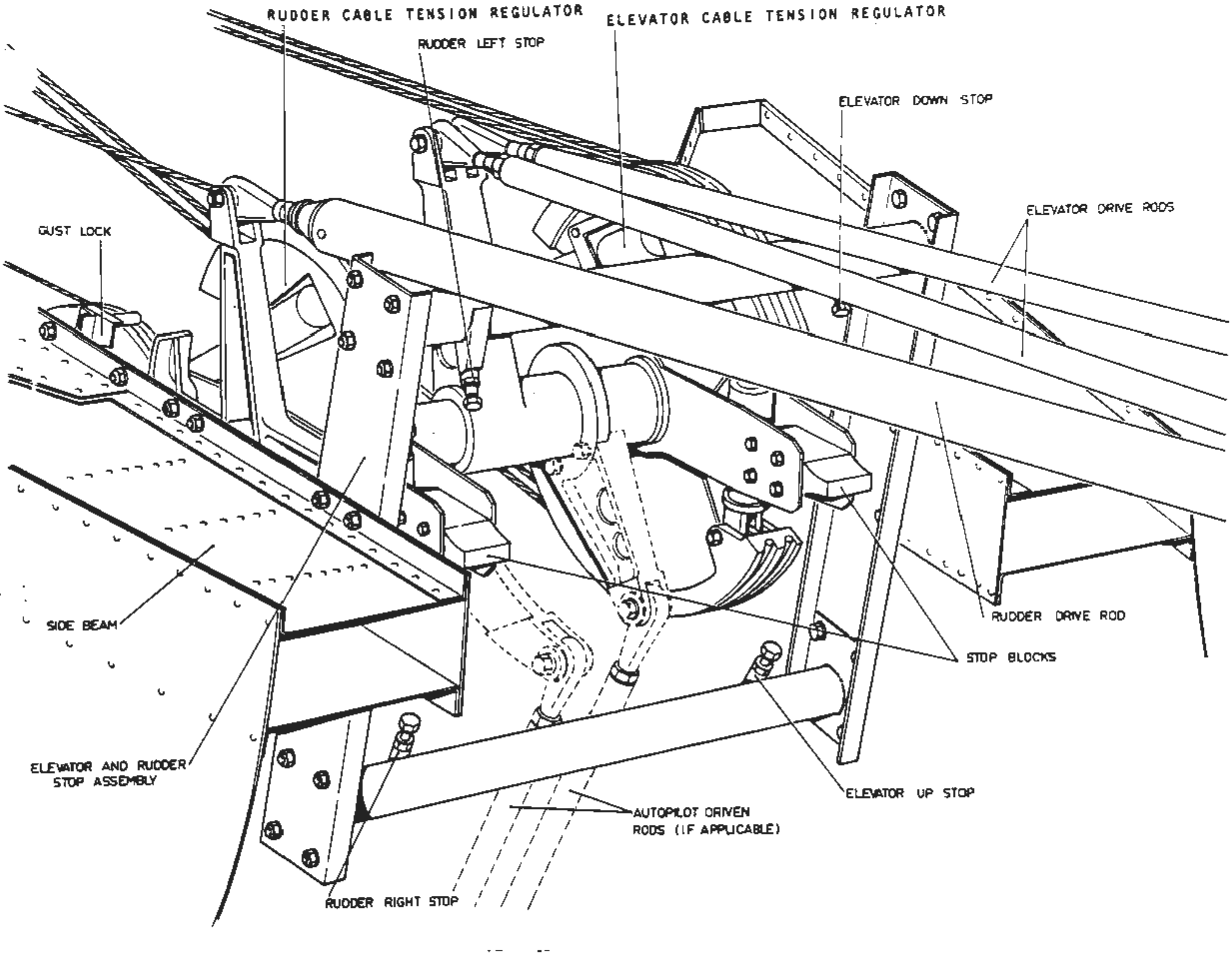


ELEVATOR SYSTEM INSTALLATION BEHIND COCKPIT REAR WALL

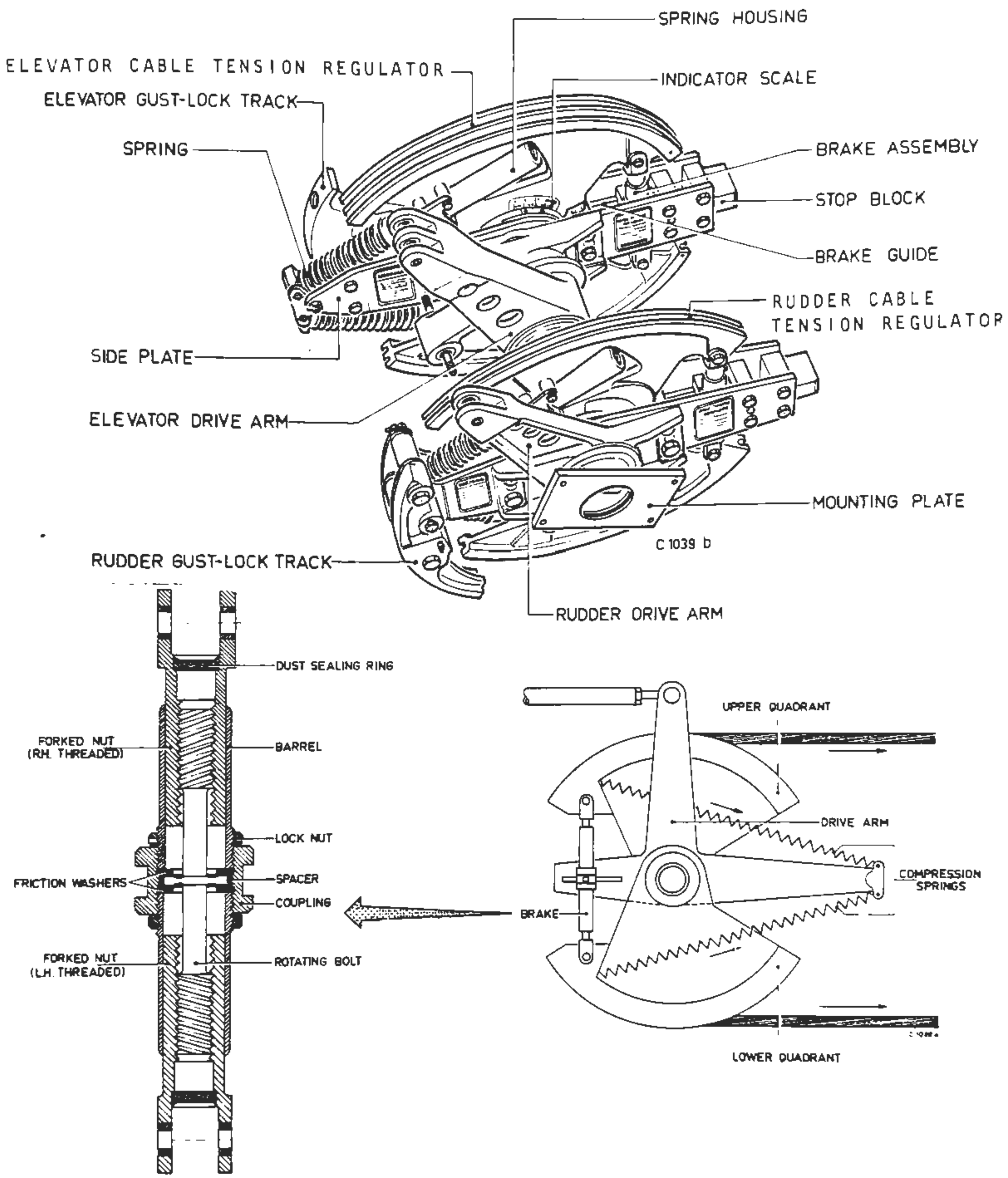


ELEVATOR DRIVE MECHANISM

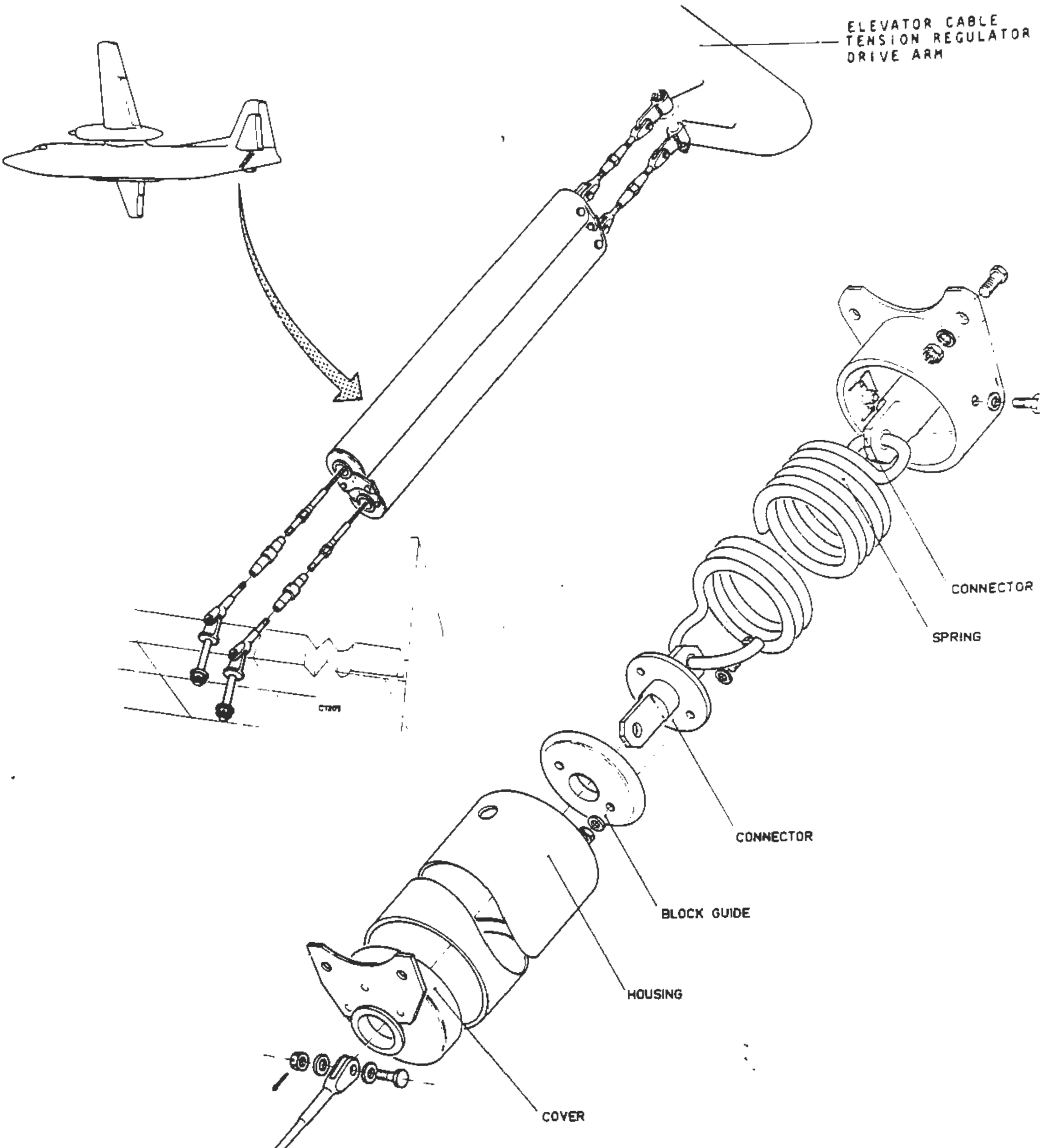




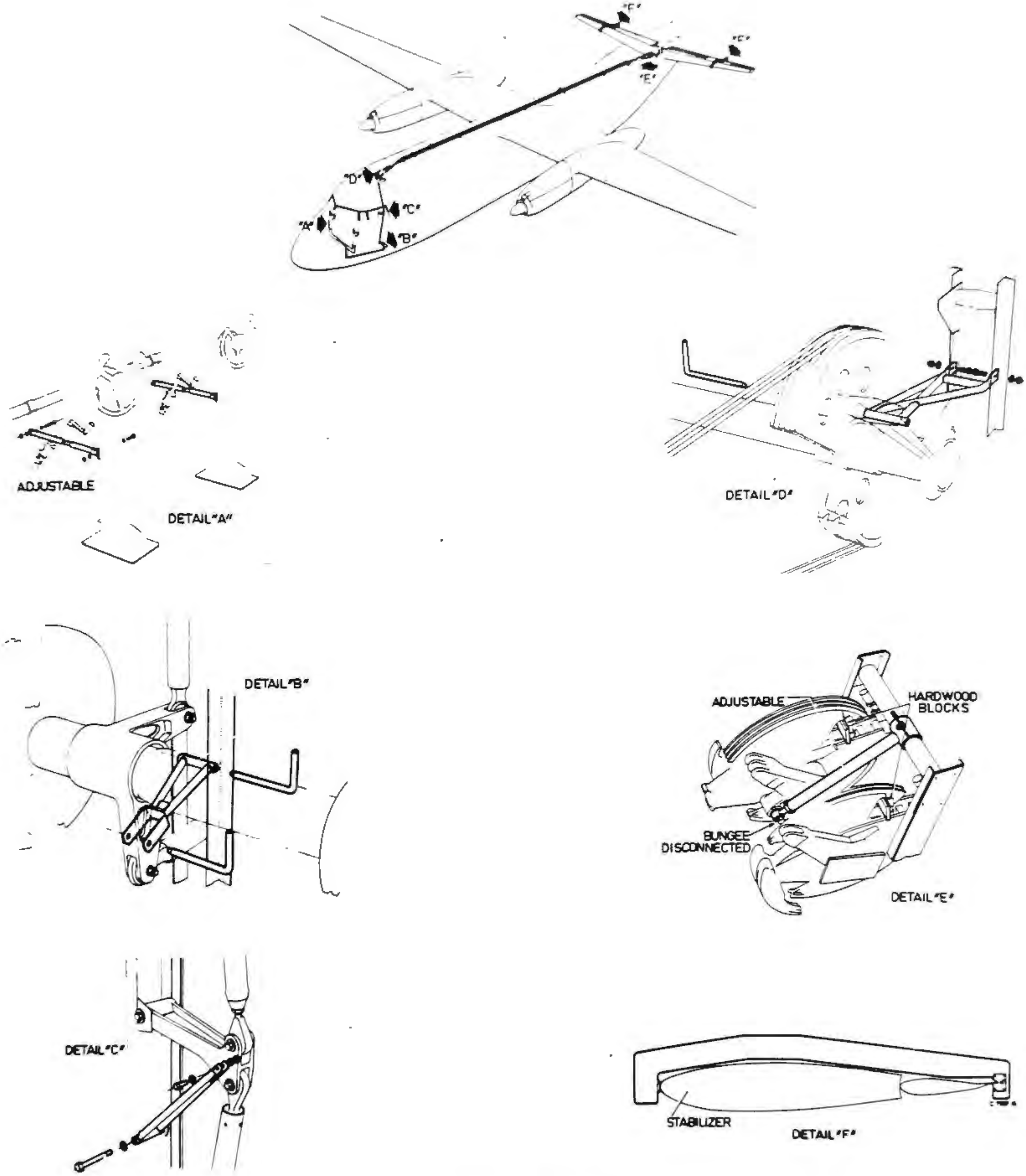
CABLE TENSION REGULATOR INSTALLATION



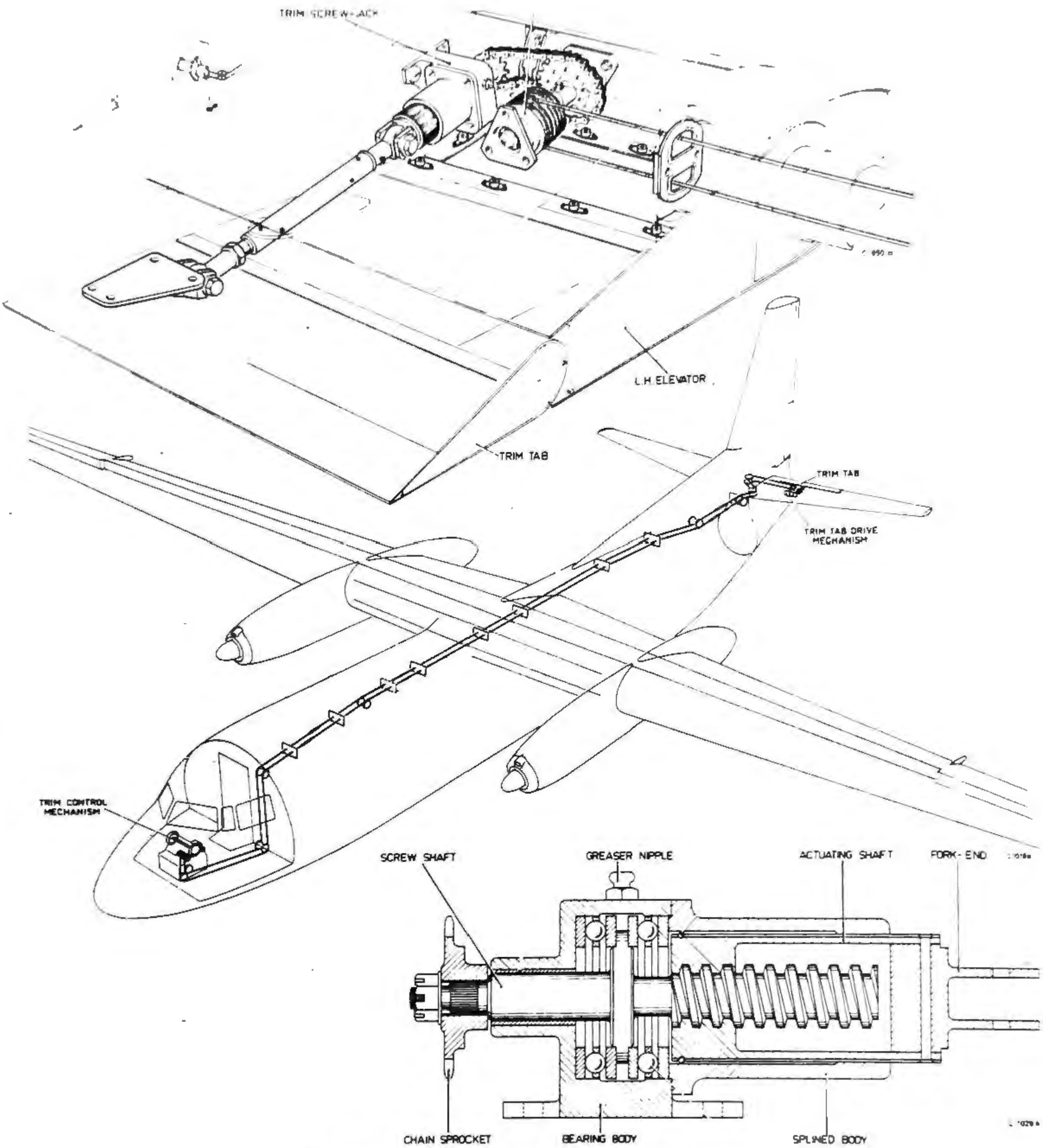
CABLE TENSION REGULATOR - PRINCIPLE OF OPERATION



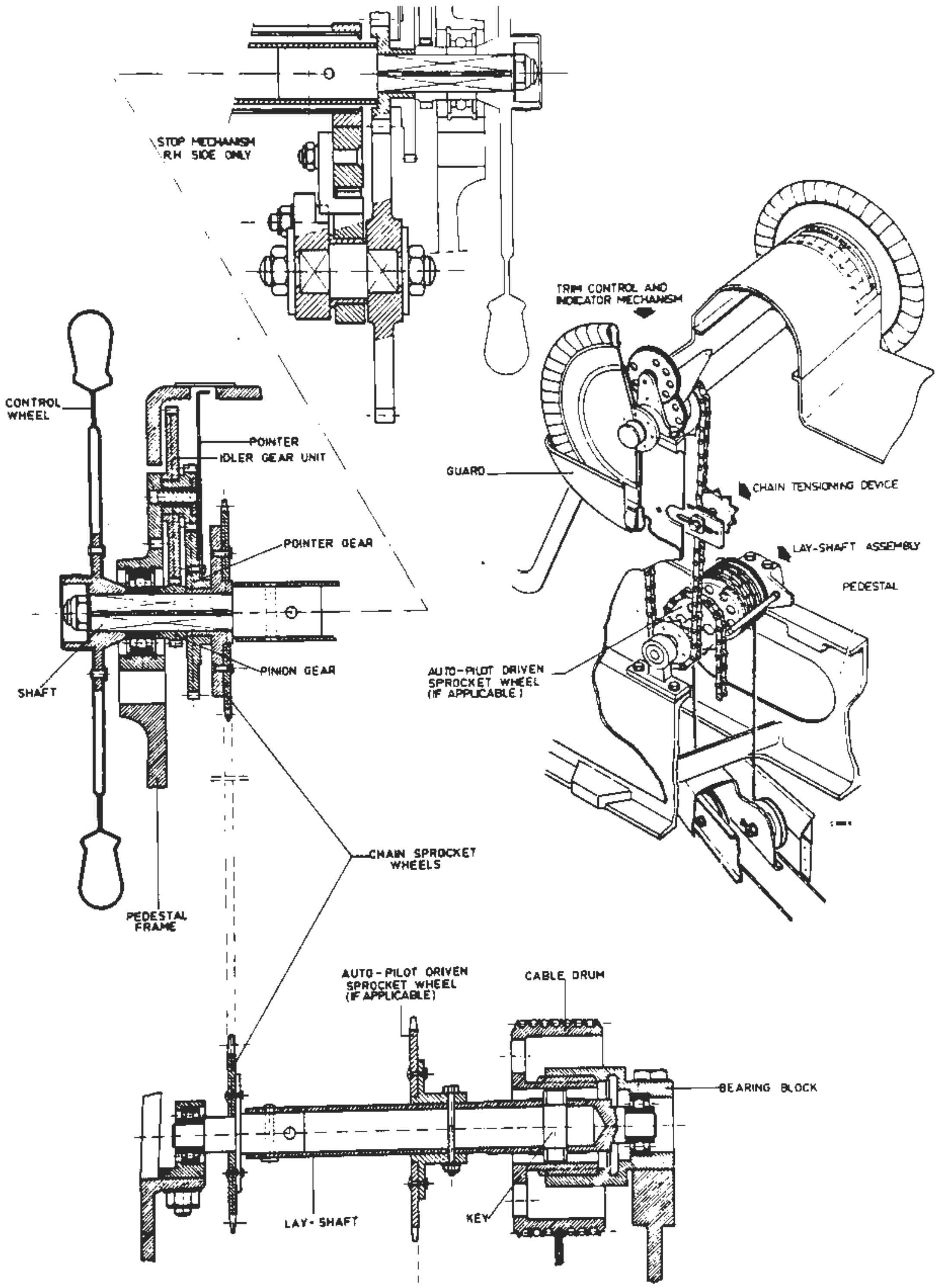
ELEVATOR BUNGEE



ELEVATOR RIGGING



ELEVATOR TRIM TAB CONTROL SYSTEM



ELEVATOR TRIM TAB CONTROL MECHANISM

50.0 FLAP CONTROL SYSTEM

Both wings are provided with an inner and an outer flap, the inner flaps are located between the fuselage and the nacelles, the outer flaps between the nacelles and inboard ends of the ailerons. The flap sections are supported at the end ribs by rollers, running in tracks which are integral with the aircraft structure. Because of their length, the outer flaps are additionally supported by a hinge at wing Sta. 6550. The outer flaps have a maximum deflection of 40 degrees, while the inner flaps have a total deflection of 26°40' (reduction ratio 2/3).

The flaps are driven by a reversible electrical actuator, controlled by a flap control handle in the cockpit. The actuator moves the flaps via torque shafts, gearboxes and threaded spindles. Each spindle moves a drive nut, mounted in a fork on the end ribs of each flap section.

The inboard and outboard spindle gearboxes are directly driven by the main torque shafts, which extend from the main drive gearbox along the entire flap span. The spindle gearboxes in the left-hand nacelle are driven by auxiliary torque shafts, extending from the main drive gearbox. The gearboxes in the right-hand nacelle are driven by an intermediate gearbox.

In case of an electrical failure the flap drive mechanism can be manually operated by means of a hand crank, which is inserted from inside the fuselage into an emergency drive gearbox in the centre wing. This gearbox and a worm drive gearbox are interposed between the main torque shafts. The worm drive gearbox is provided for driving the flap position transmitter and the drum switch of the electrical system.

Provisions are incorporated into the electrical circuit to prevent asymmetrical deflection of the flaps. Mechanical stops at the fully extended and retracted positions prevent excessive flap travel in case of failure of the limit switches.

50.1 Flap Actuator

The electrical actuator is mounted on the main drive gearbox in the left-hand nacelle.
The output shaft of the actuator is driven by a 28 V DC reversible motor through two stages of planetary gears. A torque limiting clutch protects the motor as well as the drive mechanism in case of excessive torque in the drive system. An electromagnetic disconnect assembly provides immediate disengagement of the output shaft from the planetary gears in case the motor circuit is opened.

As soon as the flap actuator is energized the electro magnetic disconnect will engage, due to the high start current in the circuit, the flap actuator to the flap drive mechanism.

NOTES: a. Do not remove the flap actuator and flap gearbox as one unit in order to prevent oil from the gearbox entering the flap actuator.
b. As the actuator is designed for intermittent duty only, a cooling period is required especially during functional tests.

50.2 Flap Control Circuit

Five flap positions, UP(0°) - 11.5° - 16.5° - 26.5° and DOWN (40°) can be selected from the cockpit by means of a flap selector handle on the pedestal. The handle is spring-loaded moved to the right (in detent) thereby depressing a selector switch in each preselected position.

To operate the flaps electrically there must be power on the main DC bus. The 115V AC power, which means inverter switched on, is required to arm the asymmetry system.

Selections

If the flap handle is selected to the DOWN position the relevant selector switch is closed energizing the down selector relay and the flap actuator will drive the flap down. When reaching the full down position a down limit switch installed in the RH nacelle and operated by the flap drive nut opens the circuit to the selector relay and the flap actuator will stop.

When selecting from DOWN to UP the up selector switch will energize the up selector relay. When flaps are fully up the up limit switch will now stop the flap actuator.

Mechanical stops in the LH nacelle will prevent flaps from overtravel when the up or down limit switch should fail. An adjustable rubber-faced stop on each end of the inboard drive spindle will then contact the drive nut. In that case the flap actuator circuit is still made and due to the friction between drive nut and stop the actuator will overload thereby tripping the flap motor C.B. on the main junction box.
When this has happened the drive shafts close to the main gear box must be inspected for overtorque.

Selections to the 11.5° - 16.5° or 26.5° positions will close the relevant switch and the relevant up or down selector relay is now energized via a drum switch installed in the centre wing. This drum switch consists of a disc with two contact rings one for up, one for down, and isolated from each other, the disc and contact rings are driven by the flaps itself. When for instance 16.5° is selected the flaps move, driving the drum switch and when at 16.5° the insulated gap is lined up with the 16.5° selector switch the flap actuator will stop.

50.3 Anti-hunt Circuit

Adjustment discrepancies in the drum switch and flap actuator clutch mechanism or increased mechanical play in the flap drive system may cause hunting of the flaps around their preselected position due to overtravelling of the drum switch. This may result in contact welding of the selector relays and damage to the actuator brushes and commutator. To prevent this an anti-hunt circuit is installed consisting of two lock-out relays.

When for instance a down selection is made the lock-out relay prevents the up selector relay from being energized at the same time, unless another selection is made.

50.4 Delay Switch and Brake Relays

When during flap travel a further or reversed selection is made, before the flaps have reached the previously selected position, the actuator must be stopped quickly to ensure that sufficient starting current is available to re-engage the flap actuator to the drive system (which was disengaged at the

moment another selection was applied). In this case the actuator is stopped through a delay switch operated by the flap handle itself and brake relays installed close to the flap actuator.
Suppose the flaps were travelling up and now the selector handle is moved to DOWN. In order to move the selector handle it must be moved to the left out of the detent, this will depress the delay switch which in turn will energize the relevant brake relay. This relay will short out the actuator winding thereby stopping the actuator very quickly. As the delay switch is on the handle the brake relays are energized to stop the flaps any time the handle is moved to the left during flap movement.

50.5 Asymmetry Circuit

Outer flap asymmetry is prevented by special asymmetry control synchros the rotors being mechanically operated by the outer flaps. The rotor of the transmitter synchro on the left-hand wing is fed from 115 V AC ess bus, and induces an alternating voltage in the stator fields. This voltage is applied to the stator fields of the transformer synchro on the right-hand wing. With the flaps in symmetrical position, the rotor of the transformer synchro is 90% out-of-phase with the rotor of the transmitter synchro. Therefore, as long as the outer flaps move simultaneously, no voltage is induced in the rotor of the transformer synchro. If, however, the movement of one of the outer flaps is interrupted, the synchro rotor of the affected side remains stationary. Continued operation of the opposite wing flap and synchro rotor causes a quickly raising output voltage of the transformer rotor, which is fed to the asymmetry control unit. If the output voltage has reached a certain value, the control unit switches over, breaks the supply to the flap selection circuit, and flap movement will cease. At the same time an asymmetry warning light near the control handle lights up.
A test switch is fitted on the maintenance test panel in the main junction box allowing the circuit to be checked for correct functioning during routine maintenance. This results in an output voltage of the transformer synchro and consequently operation of the control unit.
In four synchro positions, however, testing is impossible.

The test should therefore be carried out with the flaps moving. Operation of the test switch to test will stop the flaps and illuminate the asymmetry warning light. Resetting is performed by selecting the test switch to RESET.

50.6 Emergency Flap Up Operation

When the flaps are accidentally extended at an airspeed beyond the structural design speed of the flaps, it is possible that one of the outer flaps is rapidly forced up, due to stripping of the threads in the flap drive nuts. This results in a dangerous flap asymmetry, which can only be overcome by immediately retracting the extended flap. However, at the same time, the flap system is rendered inoperative by the operation of the asymmetry circuit. Therefore an EMERGENCY FLAP UP switch is provided in the electrical system, which provides a means for immediate UP operation of the flap system, independent of the flap control handle setting and operation of the asymmetry circuit. Operation of the switch breaks the electrical supply to the flap control unit and the "up" selector relay is energized via the "up" limit switch. The guarded and lockwired switch is positioned on the left-hand front side of the pedestal.

50.7 Flap Position Indication

The position of the flaps is indicated by a Magnesyn or an Autosyn remote indicating system. This system consists of a transmitter and an indicator, connected in parallel and excited by the same power, supplied from the 26 Volt AC bus.

50.8 Manual Flap Operation

If the electrical power supply fails in flight, or if adjustments are necessary on the ground, the flaps may be operated by hand through an emergency drive gearbox in the centre wing behind the rear spar.

The emergency flap drive crank handle is stowed in a recess in the pneumatic compartment door.

Proceed as follows:

a. Remove snap type cap in passenger cabin roof then remove fuselage pressure plug. Cabin pressure must be reduced before removing the plug. (Use reverse end of crank-handle to remove the plug).
b. Push crank in fully and push upwards for full engagement. Clockwise rotation of the handle retracts the flaps. One degree of flap movement requires 7 turns of the handle. Flap position marks for approach and DOWN are painted on the inboard sides of the nacelles and are visible through the cabin windows from the flap operating position.

CAUTION: TRIP THE FLAP CONTROL CIRCUIT BREAKER BEFORE INSERTING THE EMERGENCY CRANK HANDLE TO PREVENT ENERGISING OF THE "UP" SELECTOR RELAY.

50.9 Flap System Trouble Shooting

The following possible defects are included to familiarize the student with trouble-shooting on the flap system.

a. Flaps do not respond to a selected position

This may indicate a failure of the appropriate micro-switch in the selector switch.

Make a further selection either UP or DOWN according to circumstances.

If the flaps respond to this selection failure of a single flap selector micro-switch is indicated, and normal flap operation will be possible with the exception of that particular flap position.

b. Flaps do not respond to any selection

This may indicate either a tripped circuit breaker or a failure of the flapmotor.

c. Flaps respond only in the UP direction

This indicates a failure of the DOWN limit switch or the DOWN selector relay.

d. Flaps respond only in the DOWN direction

This indicates a failure of the UP limit switch or the UP selector relay.

e. Flaps overrun the selected position

This may indicate a failure of the drum switch.

f. Flaps overrun the normal UP position

This indicates either a failure of the UP limit switch or a sticking UP selector relay. In this case the flap drive nut will abut against the UP stop of the flap spindle, the flap actuator will be overloaded and the flapmotor circuit breaker on the main junction box will be tripped (between 15 and 60 seconds).

g. Flaps overrun the normal DOWN position

See f, but change UP in DOWN.

NOTE: In case the flaps are stopped by the mechanical stops due to limit switch failure an inspection of the spindles and universal joints in the LH nacelle will be necessary.

END

FLAP DRIVE SYSTEM

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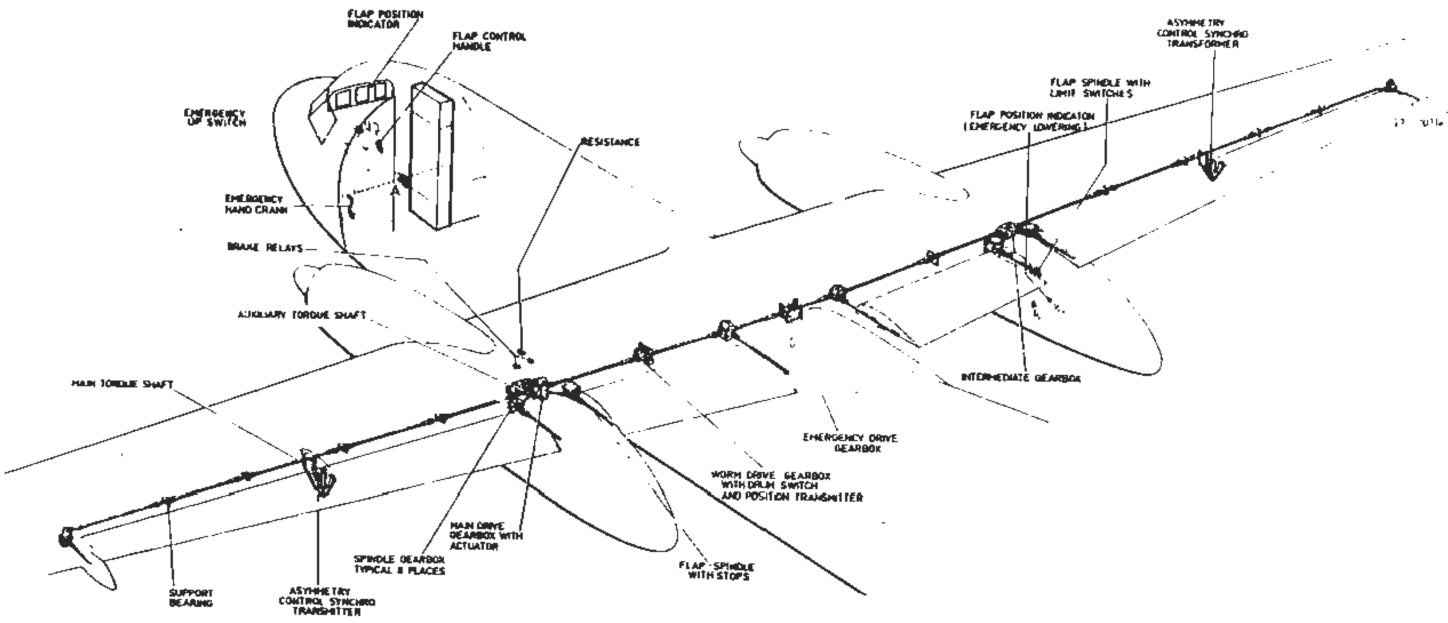
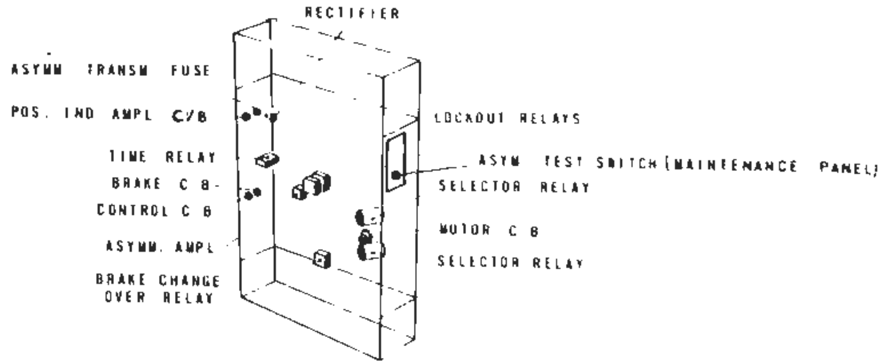
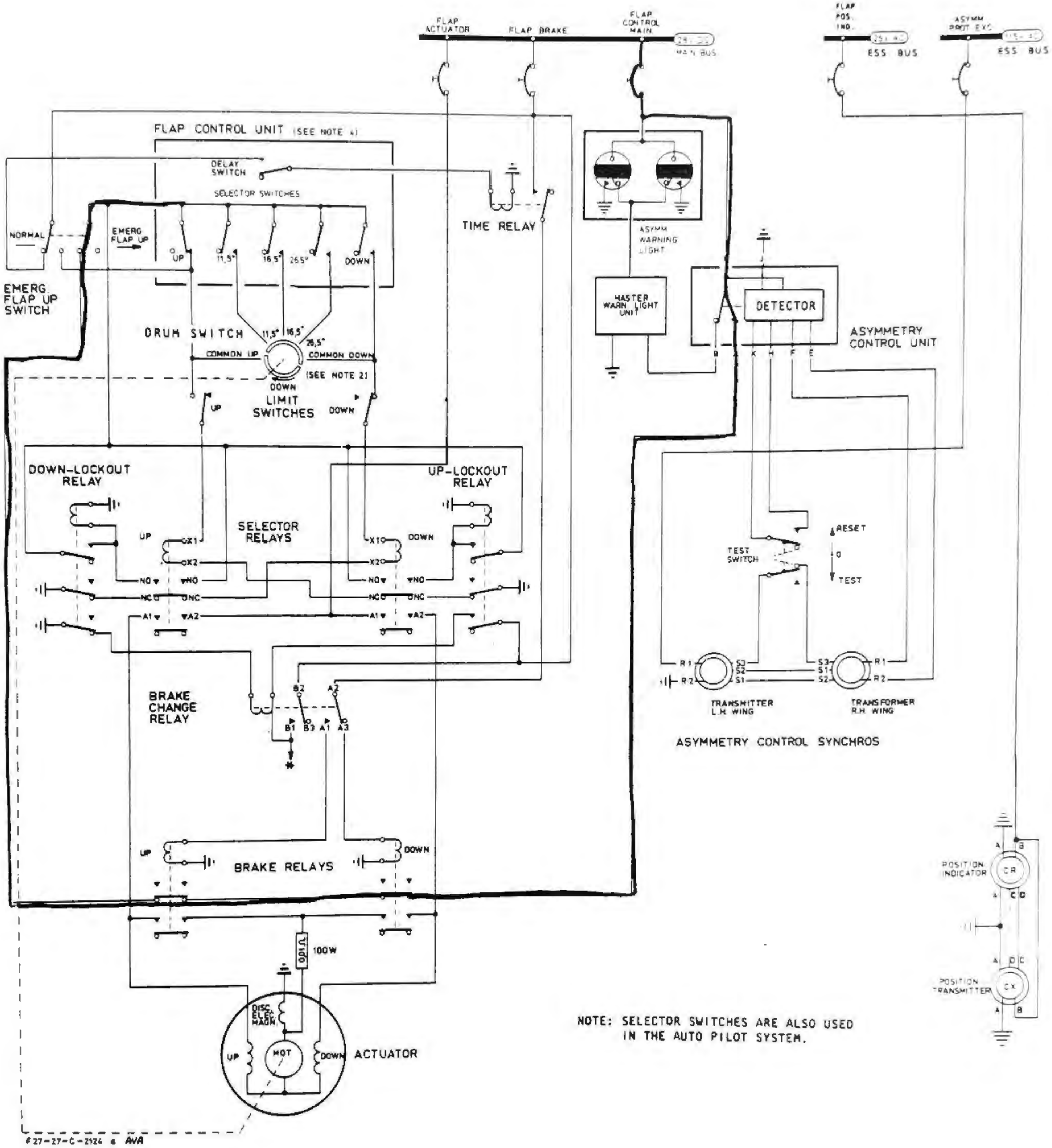
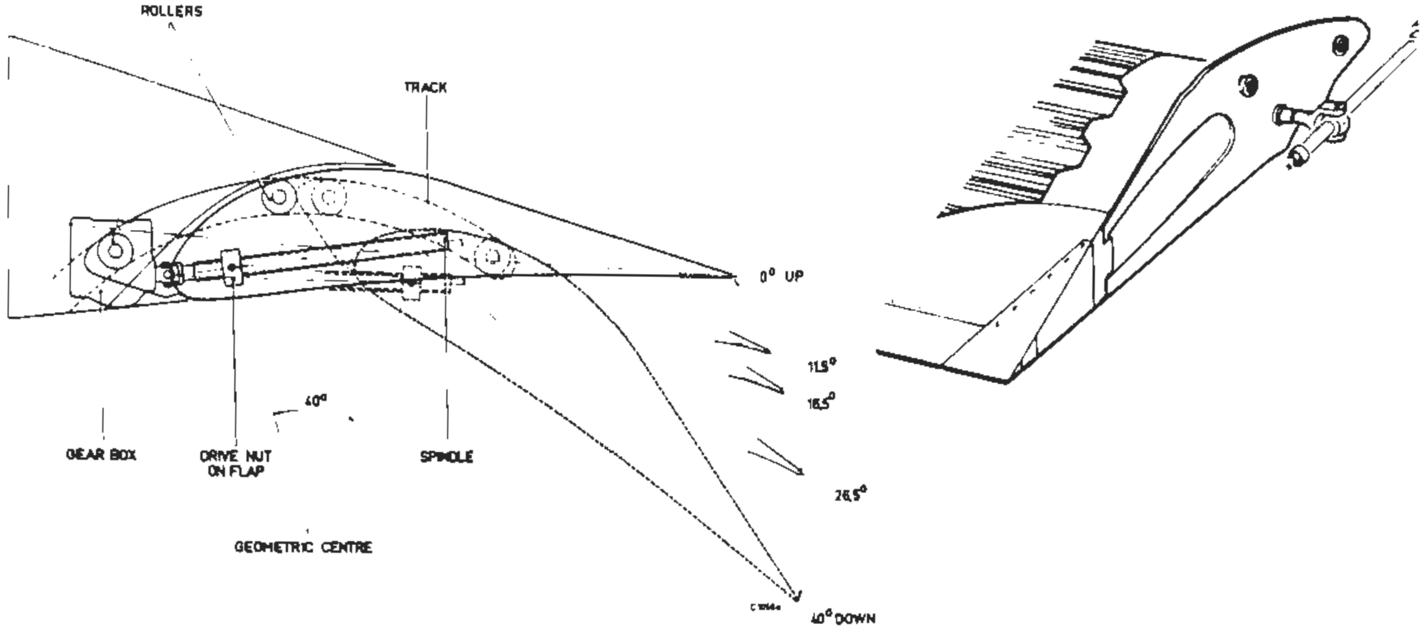


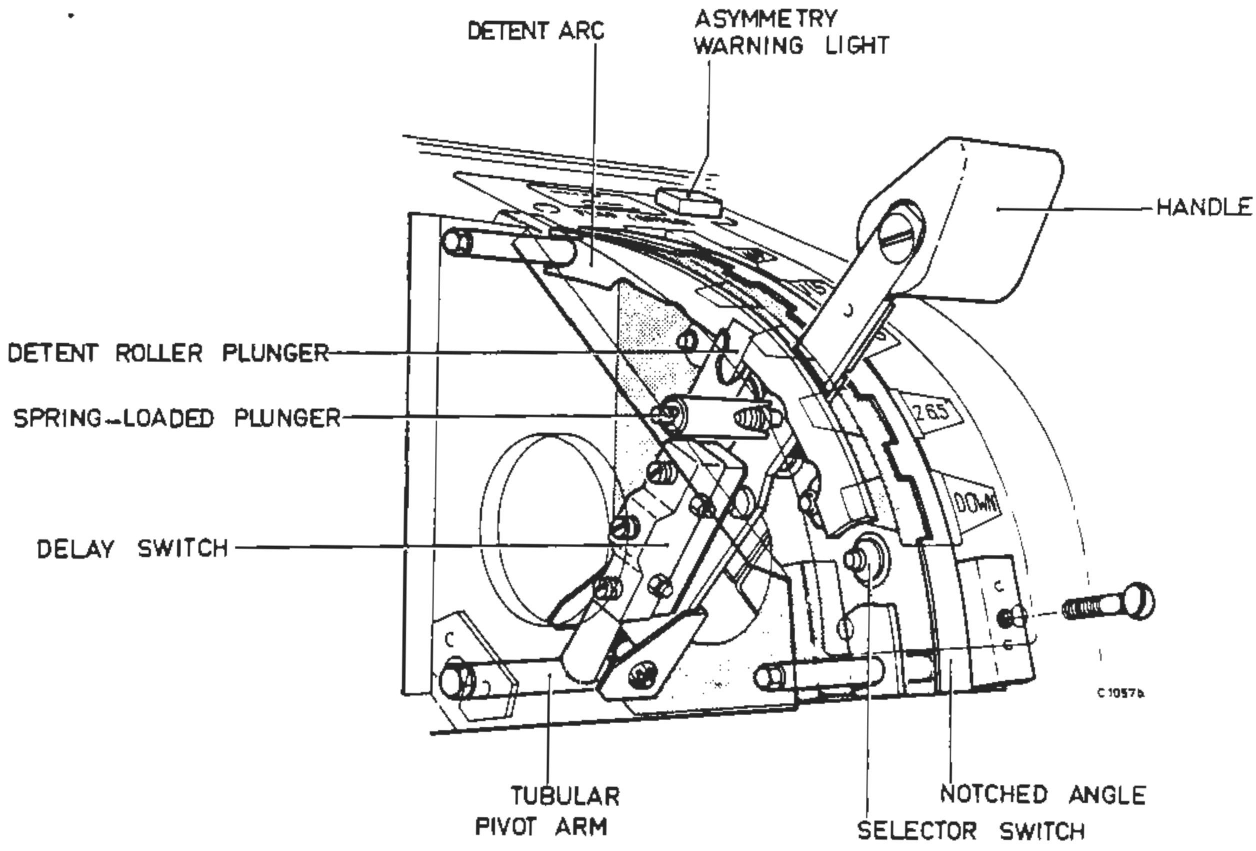




FLAP CONTROL CIRCUIT

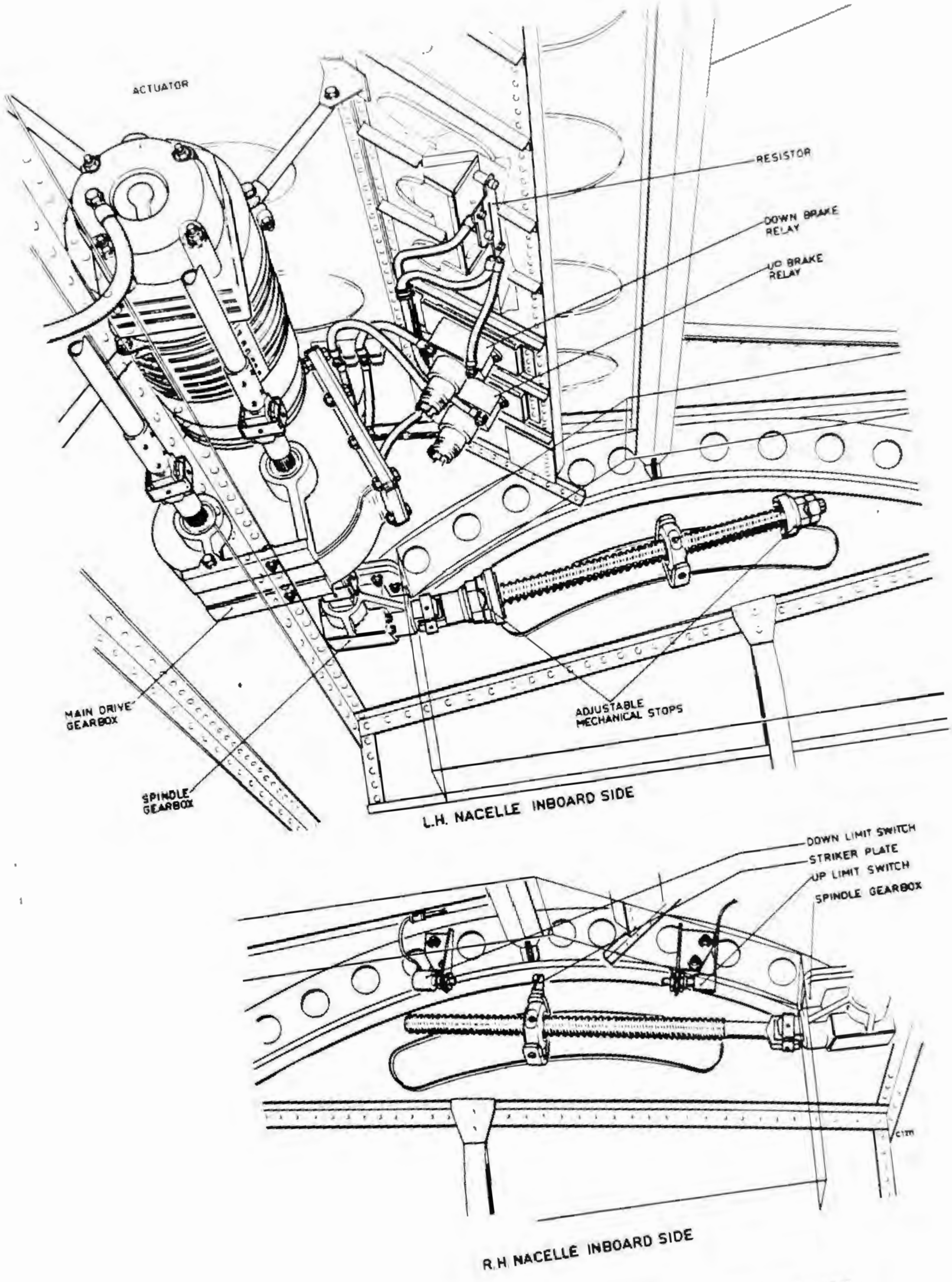


FLAP TRAVEL DIAGRAM



FLAP CONTROL HANDLE

FLAP TRAVEL DIAGRAM & FLAP CONTROL HANDLE



FLAP DRIVE INSTALLATION IN NACELLES

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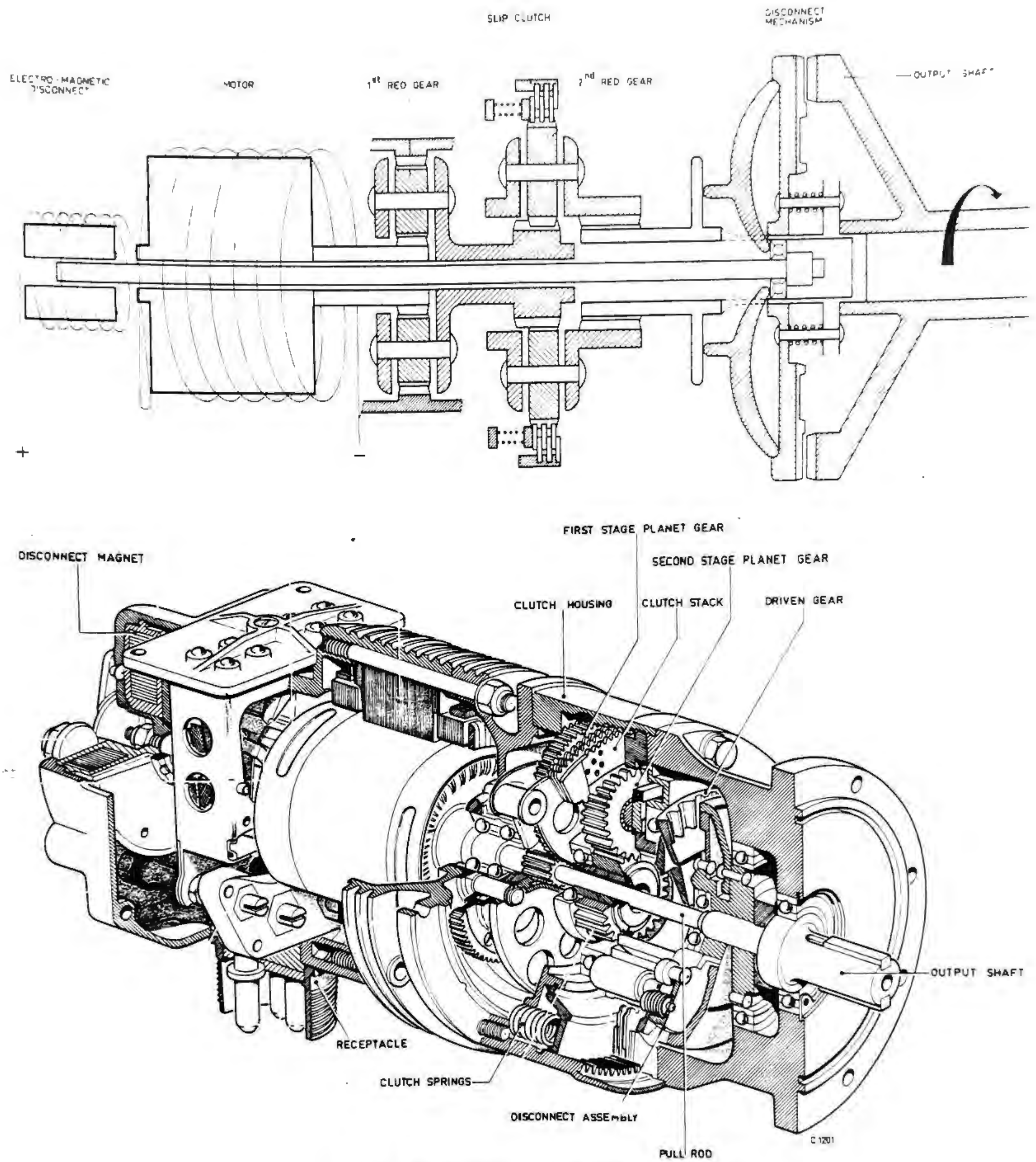
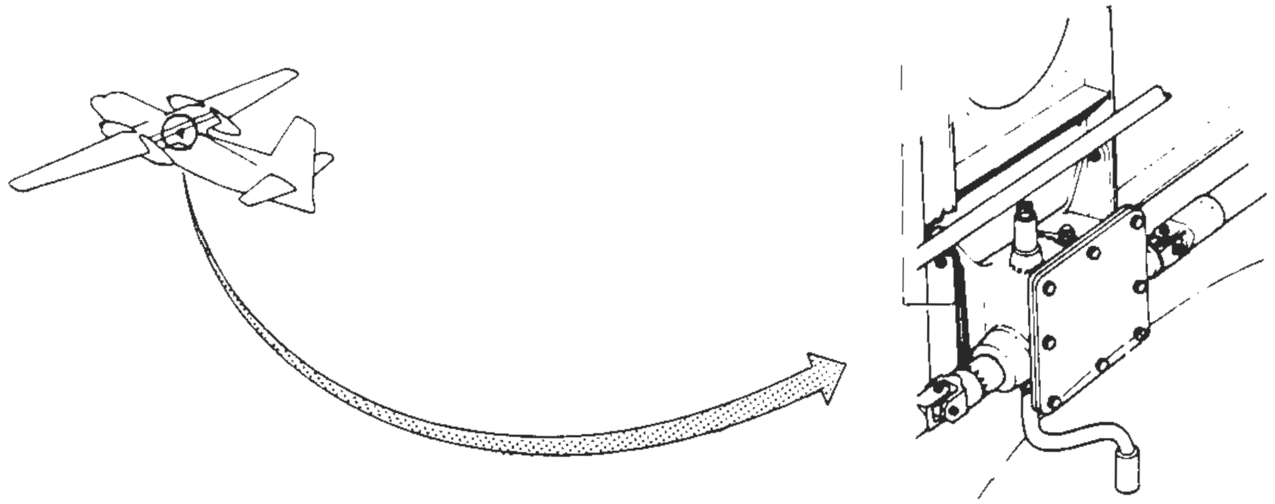
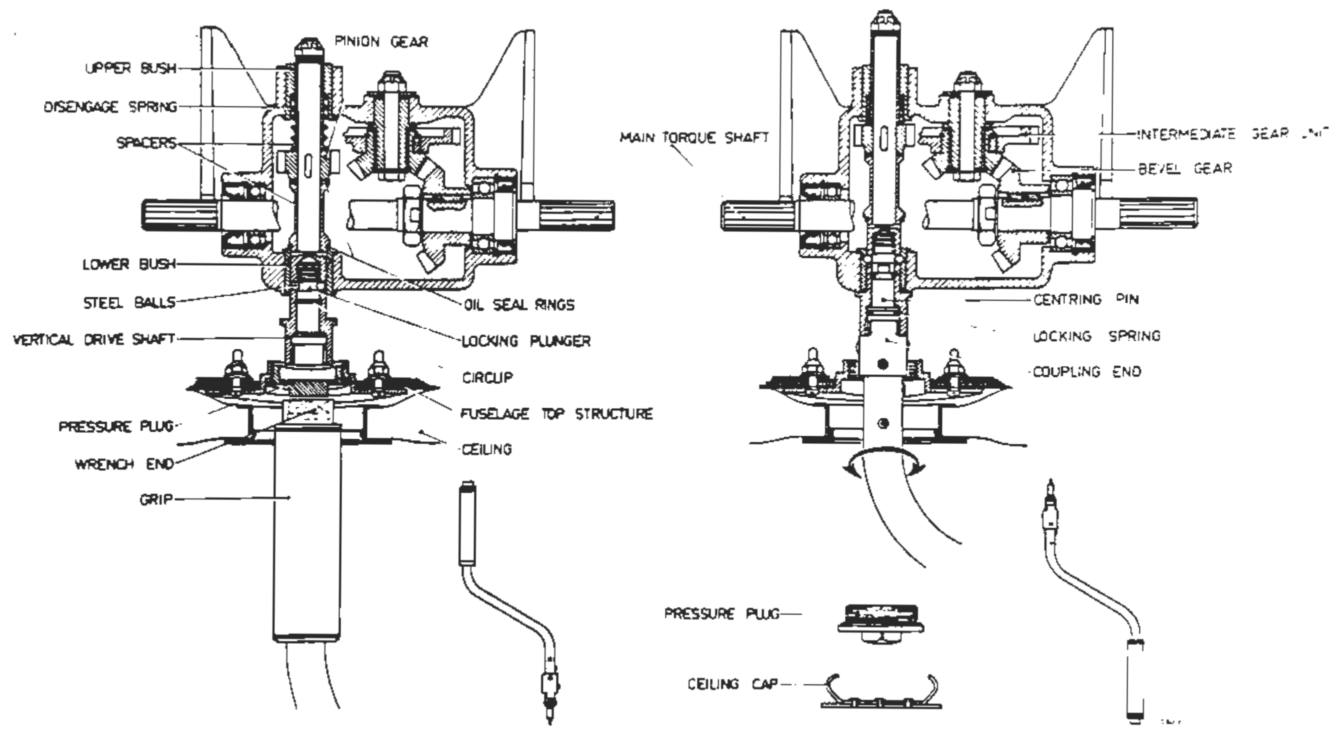


FLAP ACTUATOR - SECTIONED VIEW

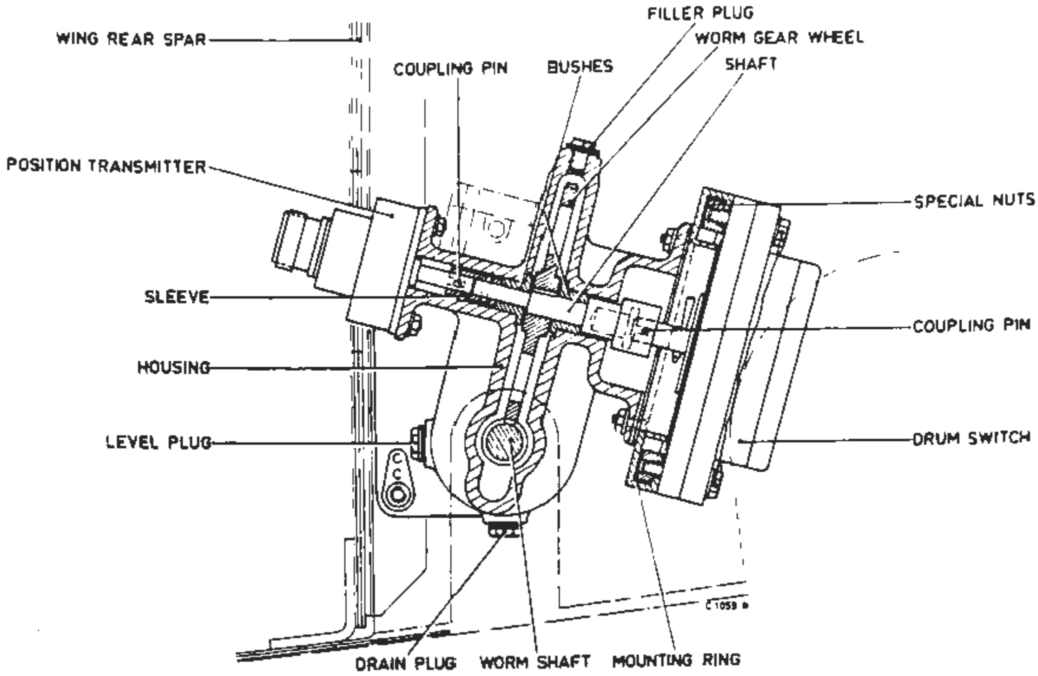




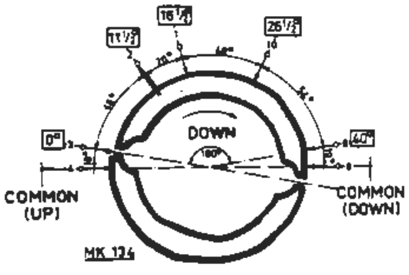
DRIVE SHAFT DISENGAGED

DRIVE SHAFT ENGAGED

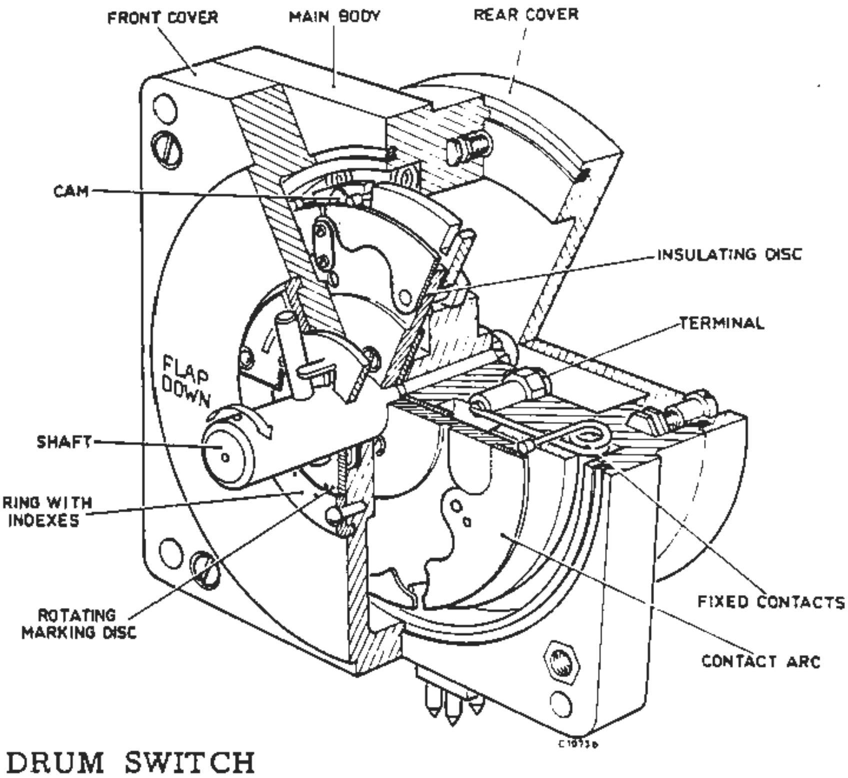
FLAP EMERGENCY DRIVE GEARBOX



WORM-DRIVE GEARBOX

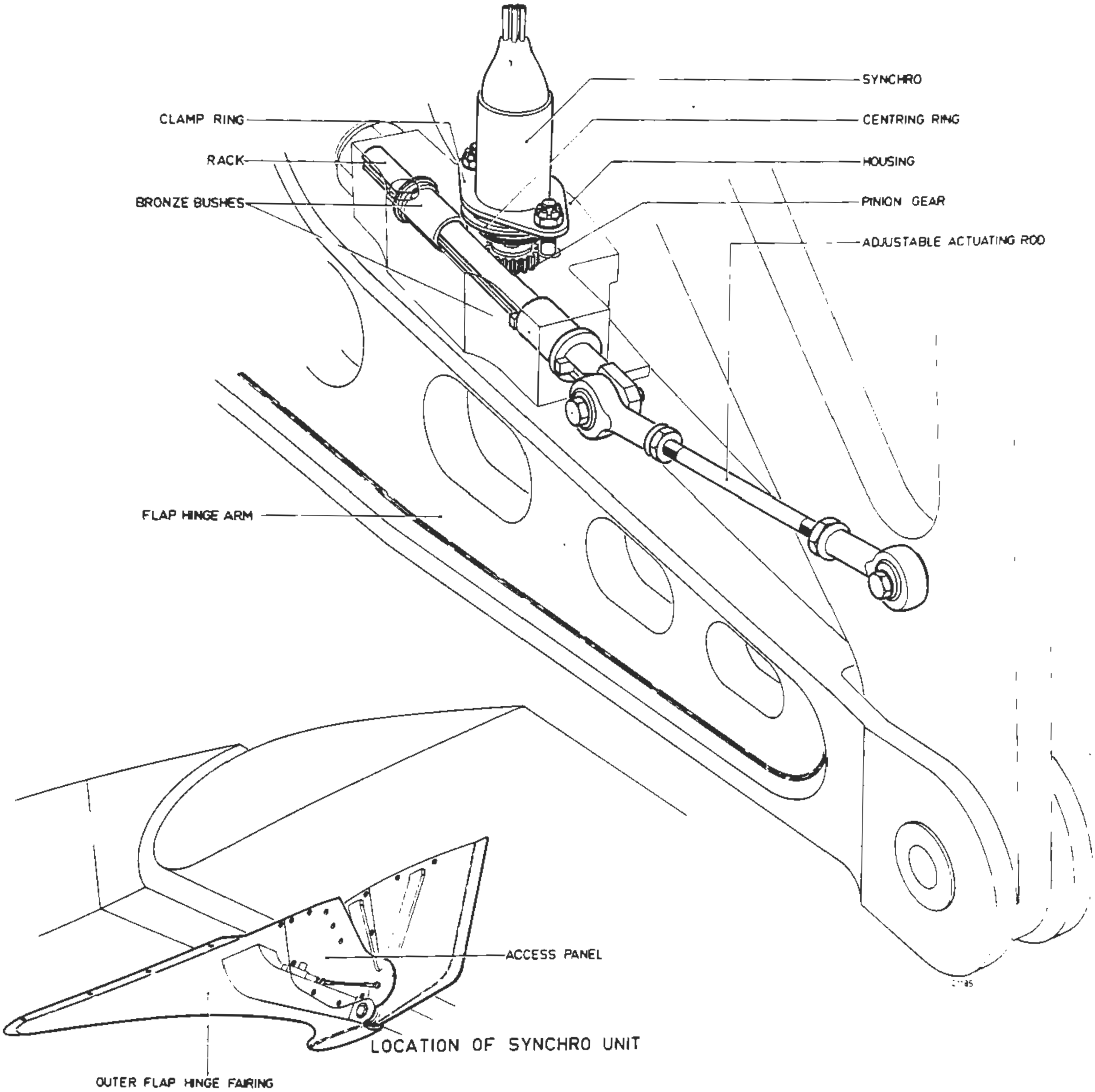


DETAIL SHOWING CONTACT ARRANGEMENT WITH FLAPS IN 0° (UP) POSITION



DRUM SWITCH

WORM-DRIVE GEARBOX & DRUM SWITCH DETAILS



FLAP ASYMMETRY CONTROL SYNCHRO INSTALLATION

70.0 GUSTLOCK SYSTEM

When the airplane is parked, damage to the flight control systems due to gusts of wind may be prevented by locking the control surfaces. The aileron and rudder are locked in the "neutral" position, the elevator in the "down" position.

The gustlock system is controlled by a lever in the cockpit. From this lever a cable is routed aft.

Between the wing front and rear spar the cables divide, one set is routed to the aileron gustlock pulley aft of the wing rear spar and the other set is routed to the common pulley of the elevator and rudder gustlocks mounted in the rear fuselage adjacent to the tension regulators. The aileron gustlock pin engages a hole in a locking plate of the aileron cross-wheel and the pins of the elevator and rudder gustlock units engage lock tracks on the elevator and rudder tension regulators.

By means of a Teleflex cable, the gustlock control lever is interconnected with an rpm control lever locking device in the pedestal. When the lever is placed in the LOCKED position it locks, besides the control surfaces, also one of the rpm control levers, thus preventing take-off with the control surfaces locked. (For detailed information see Section POWER PLANT CONTROLS).

The gustlock control lever is located on the forward left-hand side of the cockpit bulkhead (Sta. 3100). The lever handle is provided with a spring-loaded latch pin, which slides in a slotted angle strip and holds the lever in the LOCKED or UNLOCKED detent. A spring, between a lug on the drive pulley and the bulkhead, assists in turning back the control lever to the "UNLOCKED" position. A damper cylinder is also fitted to the drive pulley to reduce the force of the spring action.

TWo micro-switches connected with the propeller electrical system are operated by a cam on the drive pulley. (For detailed information, refer to Section PROPELLER SYSTEM).

All three gustlock units are similar in construction and are operated by cable-operated rack and pinions. Each unit is spring-loaded to the UNLOCK position to prevent inadvertent locking of the control surfaces in flight due to failure of the gustlock control cable system.

The locking pins in the hollow gear racks are also spring-loaded to prevent damage if the gustlock system is operated whilst the pins are not opposite the holes in the lock tracks or lock plate.

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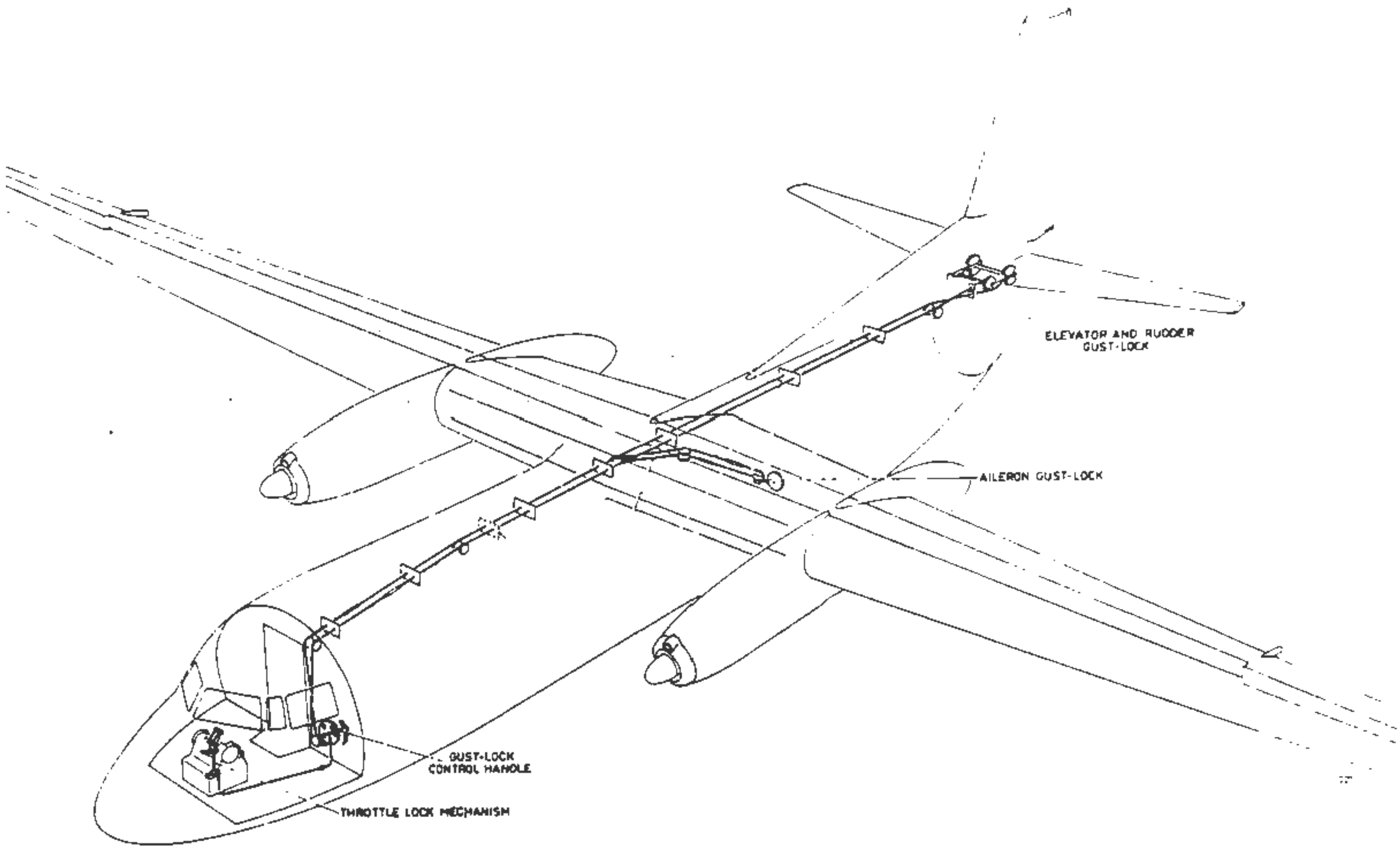
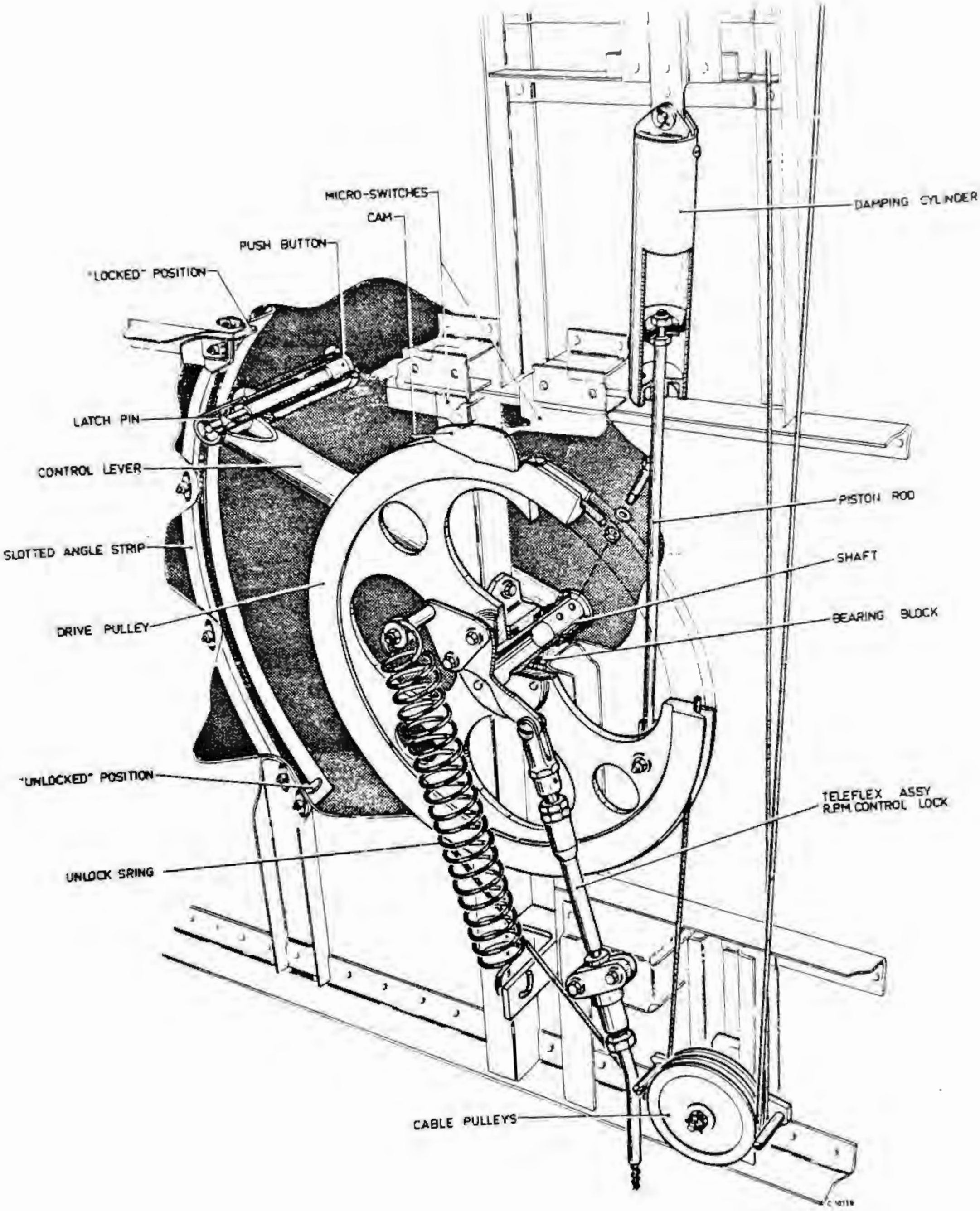
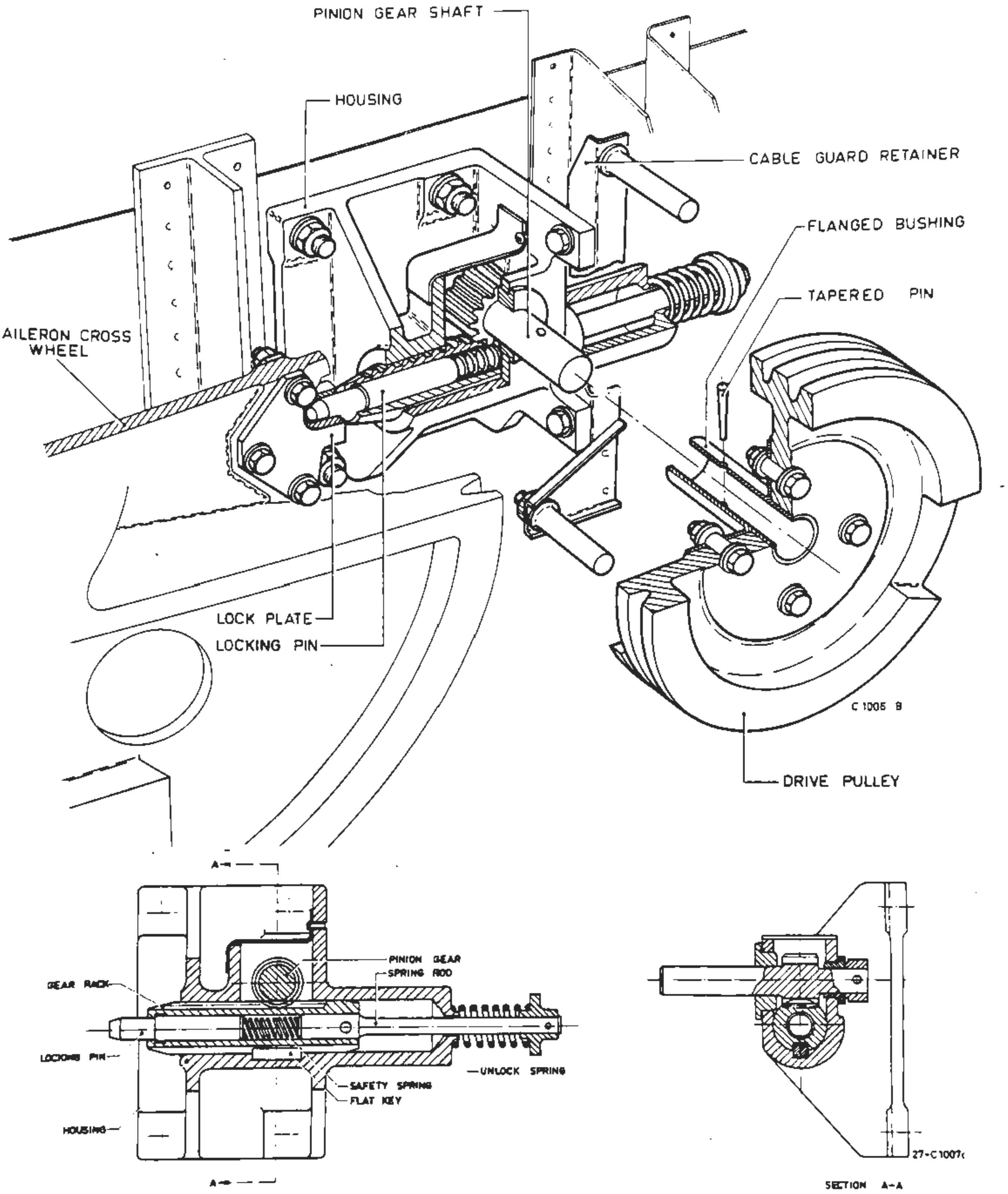


GUSTLOCK CONTROL SYSTEM

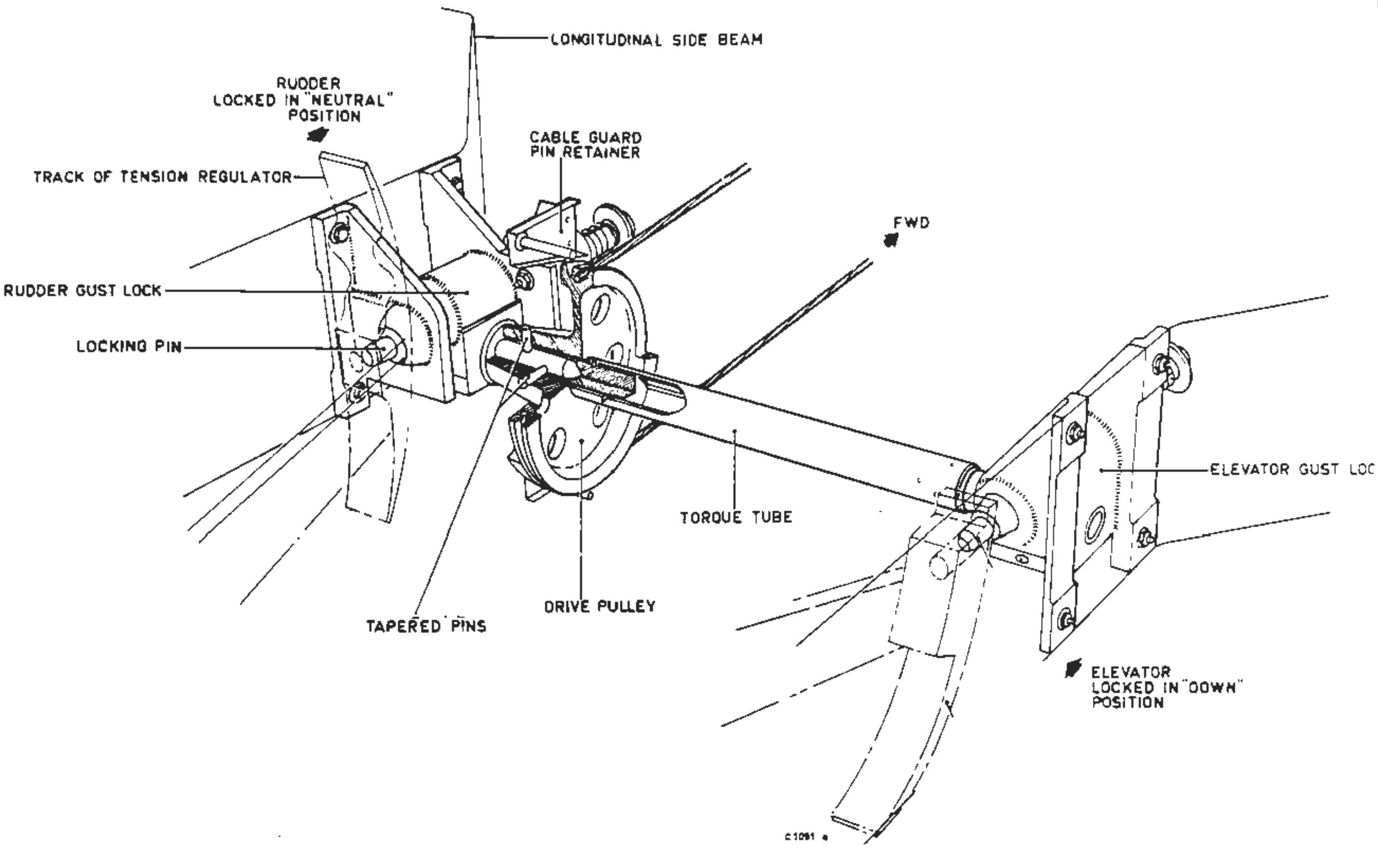


GUSTLOCK CONTROL MECHANISM ON COCKPIT REAR WALL

A/P-E



AILERON GUSTLOCK INSTALLATION



ELEVATOR AND RUDDER GUSTLOCK INSTALLATION

28 FUEL

10.0 FUEL STORAGE SYSTEM

From the main tank the fuel is supplied via two screened outlets by gravity into the collector tank. The purpose of the collector tank is to supply an uninterrupted airfree fuel flow to the engine-driven fuel pump.

10.1 Main Tank

Each main tank has a usable capacity of 4390 lb (JP-1). The tanks are sealed with a rubber-like sealant, with a top coating over the entire inner surface to prevent fungus. Each tank incorporates baffle-plates to prevent excessive fuel movements. For maintenance purposes access panels are provided in the lower surface of the tanks.

10.2 Filler Cap

A filler opening with a quick release cap is provided in the top wing skin. The latches of this filler cap are extended or retracted by turning the cap lever. An overflow-pipe prevents overfilling of the tank and is closed by the filler cap when installed. A PVC covered steel cable secures the cap to the wing structure.
The filler cap is a combined filler cap/relief valve. When the pressure in the tank exceeds 2.6 psi, the cap is lifted while the cap base, with the latches, remains in the locked position.

10.3 Tank Drain Valve

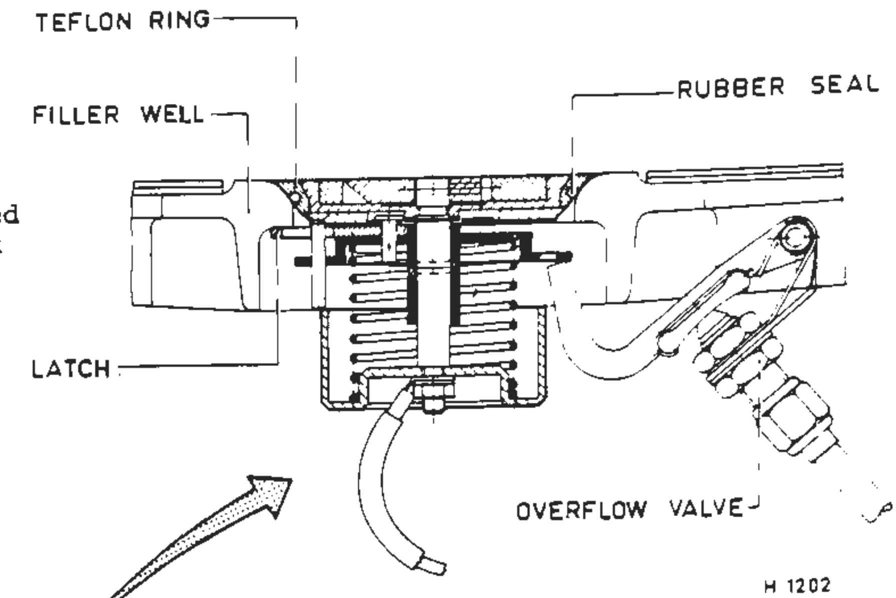
A spring-loaded, plunger-type drain valve is located at the lowest point of the main tank. The valve is utilized for draining accumulated water from within the tank or may be used to drain residual fuel when defuelling the tank. Two O-ring seals, of which the lower one seals the valve, are installed to prevent leakage. The upper ring prevents fuel spillage when the seat plate is removed for replacement of the lower ring with a full tank.

10.4 Collector Tank

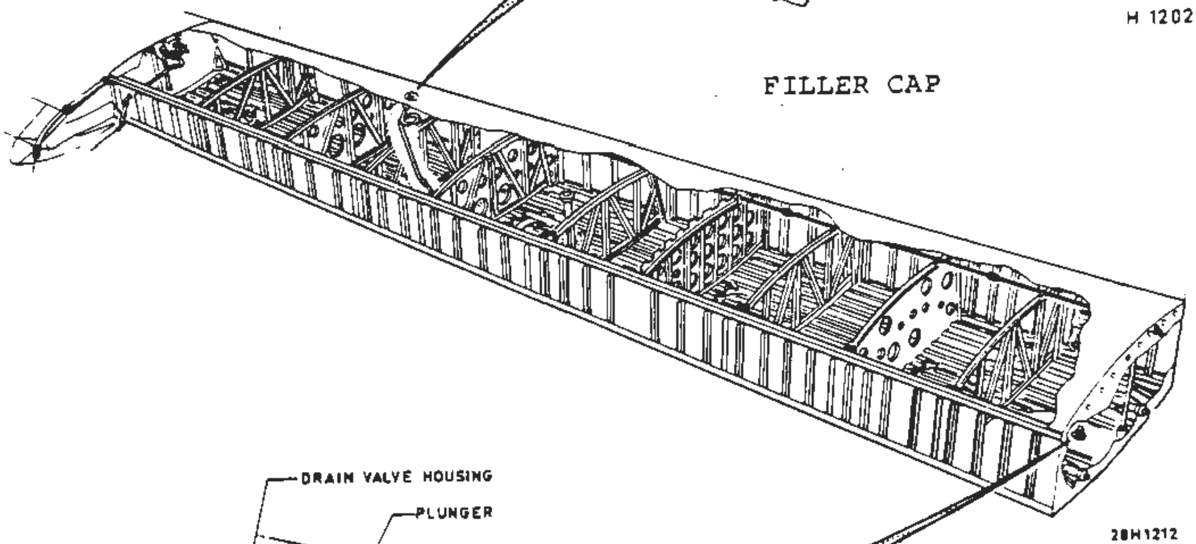
Each collector tank has a usable capacity of 90 lb (JP-1). The welded stainless steel collector tank is located on the inboard side of each nacelle supported by rubber covered brackets and secured with clamping straps. The top of the collector tank is provided with a ventilation outlet. A fuel inlet and a connection for the thermal relief return line are installed in the side wall. The collector tank can be drained via a tank drain valve, fitted in the mountin flange of one of the boosterpumps. The drain lines extend through an access panel below the collector tank.

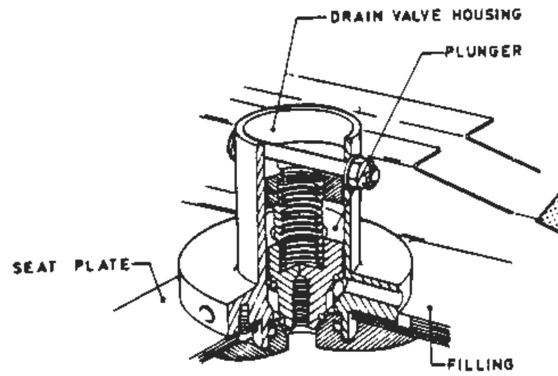
END

NOTE:
The cap must be installed with the arrow and black marking in line.



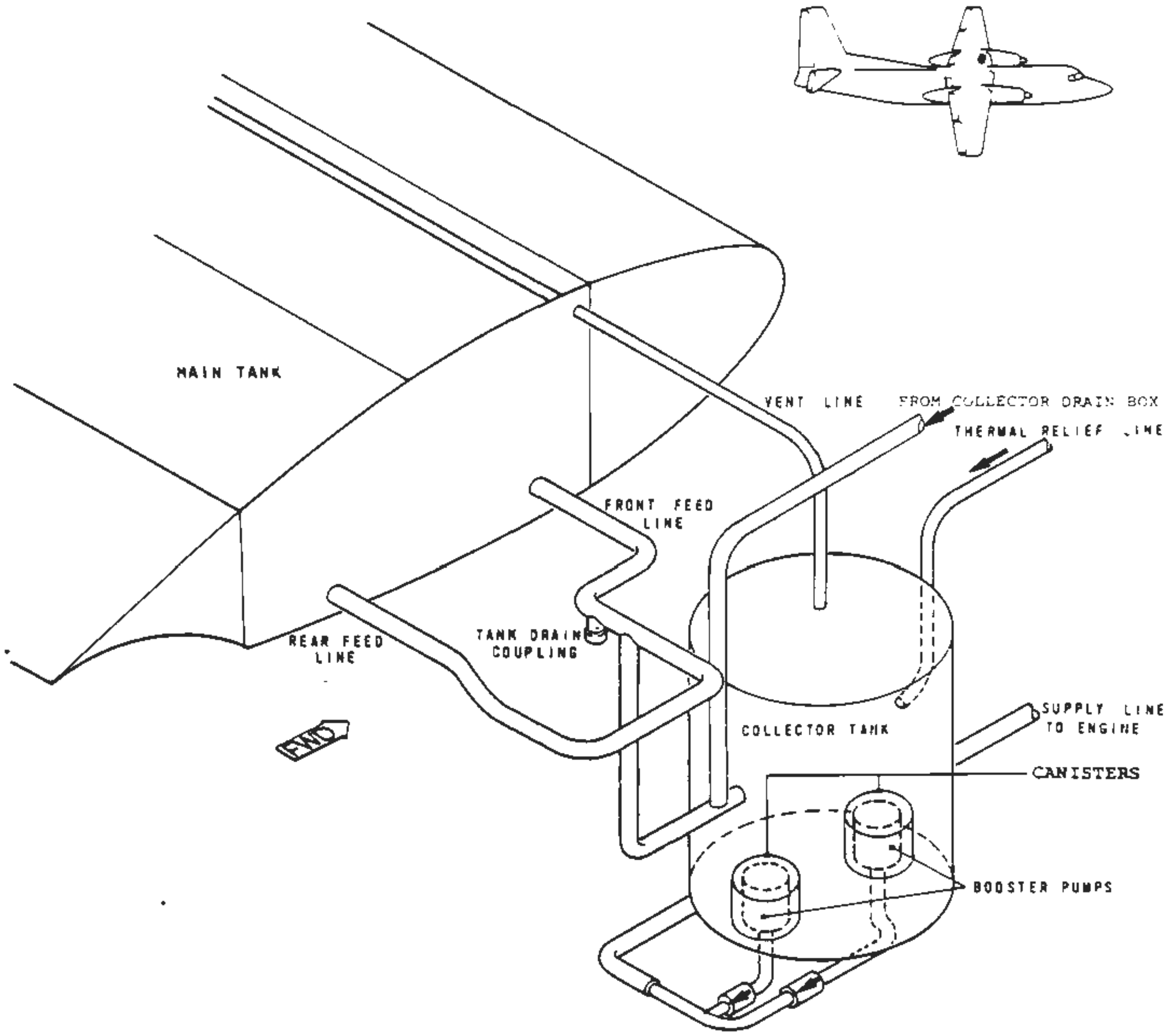
FILLER CAP





TANK DRAIN VALVE

FILLER CAP AND TANK DRAIN VALVE



GRAVITY FUEL SUPPLY SYSTEM

12.0 FUEL TANK VENTILATION

The collector tank is vented by a line routed from the top of the tank into the air space in the upper outboard end of the main tank. The main tank is primarily ventilated via a vent float valve and secondarily via a sniffle valve to atmosphere.

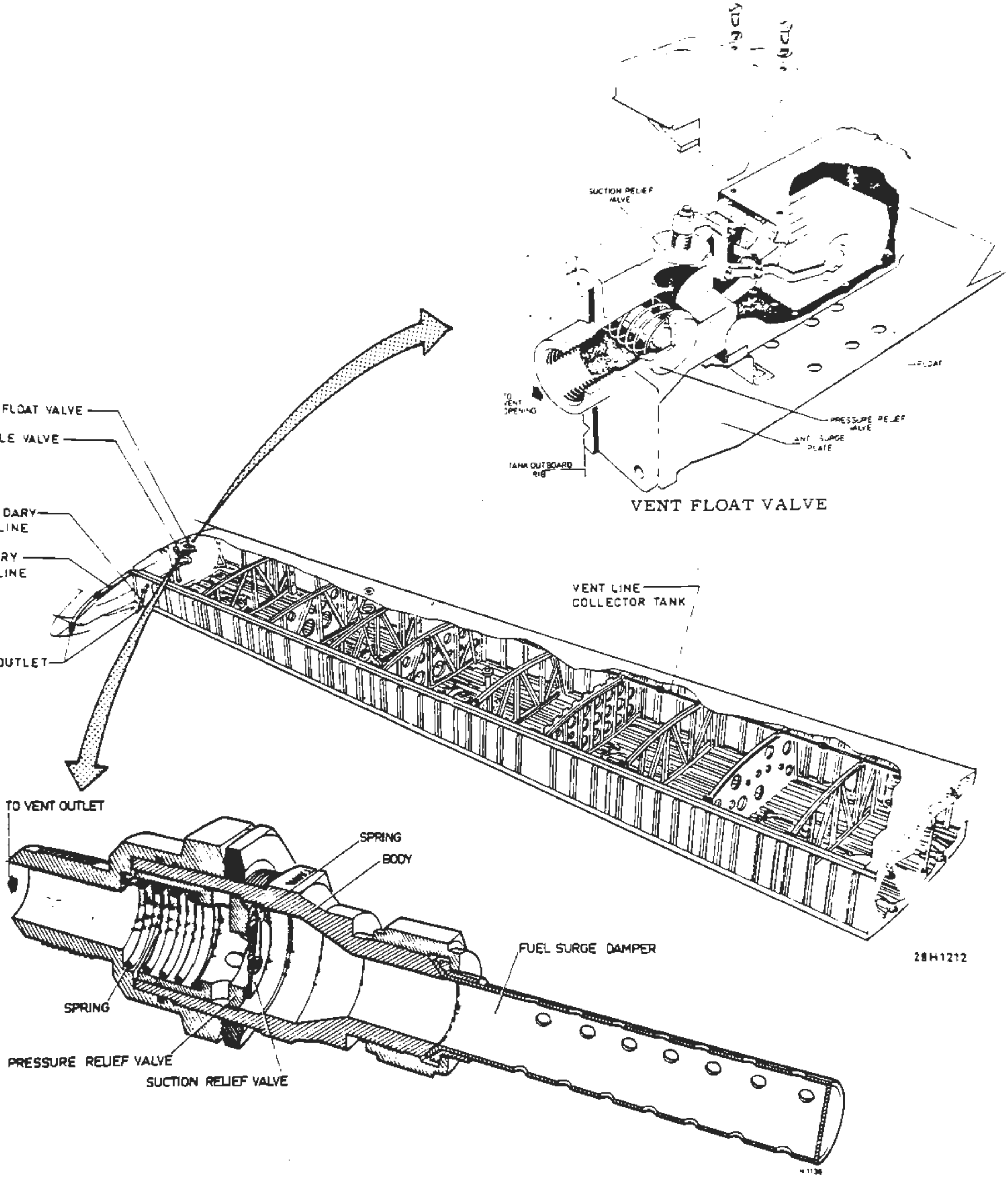
12.1 Vent Float Valve

The vent float valve is mounted in the top of the outboard main tank rib and consists of a body with a pressure relief valve and a suction relief valve. The latter is connected to a float by a linkage and the float is guarded by a cage. In normal operation the suction relief valve is held open by the float, allowing free venting of the tank. If during manoeuvres the float is raised by the rising fuel, the suction relief valve is closed to prevent loss of fuel. A differential pressure between 0.5 and 1.0 psi will cause the suction relief valve to open if the float is jammed in the raised position. The pressure relief valve prevents an excessive pressure build-up and is open at 2 psi. From the vent float valve a vent line is routed to the ventilation outlet in the outer flap rail fairing.

12.2 Sniffle Valve

This valve, located in the upper outboard end of the main tank, consists of a body, a poppet pressure relief valve and a flapper suction relief valve, the latter being incorporated in the pressure relief valve. A fuel surge damper is fitted in the suction end of the valve. The pressure relief valve opens at a pressure of 1.4 - 1.6 psi. The suction relief valve opens when the pressure in the tank drops more than 0.15 - 0.5 psi below ambient pressure. The sniffle valve ventline is routed to an outlet port in the wing trailing edge.

END



MAIN TANK VENTILATION SYSTEM

20.0 FUEL SUPPLY

TWo electrically operated boosterpumps are installed in each collector tank. The pressure of normally one operative boosterpump is sufficient to ensure correct functioning of the engine-driven fuel pump. Each boosterpump discharges the fuel under pressure via a check valve into the supply line. In this supply line are installed, a shut-off valve, a fuel flow transmitter and a fuel heater. Via the engine fuel filter the fuel enters the engine fuel system. Clogging of the filter is indicated in the cockpit by an amber light on the RH overhead panel.
Possible ice in the filter can then be removed by setting the fuel heater in operation by moving the FILTER HEATER switch to ON. This switch is located just below the relevant warning light.

20.1 Booster Pumps

Each collector tank is provided with two submerged, electrically-driven centrifugal booster pumps, each fitted in a canister to the bottom of the collector tank. The forward pump is called "no. 1", the aft pump "no. 2".

The booster pumps can be operated from the RH overhead panel, where two pairs of switches are located, one pair for the RH and one pair for the LH fuel system. With each switch the relevant booster pump can be controlled.

Before the engines are running the booster pumps are powered from the main DC tie bus. As soon as the LH generator comes "on line" both booster pumps no. I will be powered directly by the LH generator through the operation of a change-over relay which becomes automatically energized by the LH generator. The RH generator will in the same way power the booster pumps no. II.

However, if for any reason a generator goes "off line", the relevant booster pumps will automatically switch back to the main DC tie bus. In case both generators fail and with essential power selected the booster pumps no. I and II will be powered from the "battery bus" via the Ess. DC bus I and Ess. DC bus II respectively.

The impeller is mounted on the shaft of a wet 28-V DC motor, mounted in a closable canister.
Fuel enters the canister through a screen on the side of the canister housing. Via the canister fuel will enter the boosterpump and is discharged into the supply line through a check valve. Each pump is provided with a drain valve, the drain lines extend through the access door beneath the tank.

To remove the pump, the canister must be isolated from the collector tank by a fuel shut-off valve operated by a lever on the outside of the canister. By removing the locking screw in the lever, the lever will come down by springforce, simultaneously closing off the canister. The canister now can be drained by the drain valve and when empty the pump can be removed after disconnecting the electrical wiring and removing a retaining ring.

Each pump has its own pressure switch connected with sensing lines to the booster pump outlet. The pressure switches are located on the inboard side of the nacelle. Whenever the pump delivery pressure drops below 6.5 psi (JP-1), the relevant pressure switch contact closes and the relevant amber fuel pressure caution light, located above the booster pump control switch, will illuminate. Each pressure switch is connected in series with both booster pump control switches. The fuel pressure caution light circuits are controlled by the booster pump control switches in such a way that when an individual pump is switched off, the associated pressure warning circuit is disarmed and the fuel pressure caution light will not illuminate. When an individual pump is switched on its associated fuel pressure caution light is armed and consequently if its pressure caution switch closes, the relevant fuel pressure caution light will illuminate.

If both pumps in one collector tank are switched off, the fuel pressure caution lights of both pumps will be illuminated.

20.2 Tank Isolating Valve (Not applicable)

20.3 Fuel Shut-Off Valve

This slide valve is fitted to the front of the manifold. The valve is installed to shut off the fuel supply forward of the firewall in case of an engine fire or maintenance operations. The valve consists of a body and a cover. A movable slide in the body is operated by a crank, which is engaged to the square shaft end. A drive arm, splined to the square shaft, is operated by a cable system.
The fuel shut-off valves are manually operated by "T" handles, located on the glareshield panel in the cockpit.

20.4 Crossfeed Valve

Connected to the top part of the manifold is a crossfeed valve in order to enable cross-feeding via the crossfeedline and the other crossfeed valve to the other engine. The cross feed valves are simultaneously and manually controlled by a crossfeed knob, located on the aft side of the pedestal in the cockpit.
The rotatable valve consists of a body and a carbon assembly which opens or closes the crossfeed line.

20.5 Crossfeed Bleed Valve

This valve consists of a housing and a plug. The housing is riveted to a bracket on the wing structure. The plug screwed into the housing extends through the lower right-hand wing fuselage fillet. The bleed line routed from the highest point of the crossfeed line is connected to the housing. For bleeding the fuel system the plug must be unscrewed a couple of turns.

20.6 Thermal Relief Valves

Relief valves are installed in order to protect the fuel lines against excessive pressures due to temperature rise in trapped fuel. They relieve into the collector tank. These valves are installed in the relief line from the outlet fitting of the fuel flow transmitter, the relief lines from the manifold and crossfeed line. The crossfeed line thermal relief valve can be found in the LH fuel system only. All valves have a cracking pressure of 15 psi.

20.7 Fuel Heater

The fuel heater is a shrouded heat exchanger, installed in the fuel line between the fuel flow transmitter and the low pressure filter. When the system is selected "ON", hot air, tapped from the second stage of the engine compressor, passes through the heater and is dumped overboard via an outlet, located at the bottom of the nacelle. When the system is selected to "AUTO" automatically the fuel heater is switched on at the time the fuel heater differential switch switches the filter light to on.

20.8 Hot Air Gate Valve

A solenoid operated hot air gate valve controls the hot air supply to the fuel heater and is controlled by the FUEL HEATER switch in the cockpit.
The hot air gate valve is operated by air pressure controlled by a pilot valve attached to a solenoid. Two pistons of unequal area are connected by a rod which carries a carbon slide valve. The head of the smaller piston is subjected to atmospheric pressure and its inner face to engine compressor air pressure. The larger piston incorporates an air bleed and is therefore subjected to compressor air pressure on both sides. When the solenoid is energized, the pilot valve is opened, allowing the pressure on the outside surface of the large piston to vent to atmosphere, resulting in opening of the slide valve. When the solenoid is de-energized, the pilot valve closes, pressure is built up and the resulting forces will close the hot air gate valve.

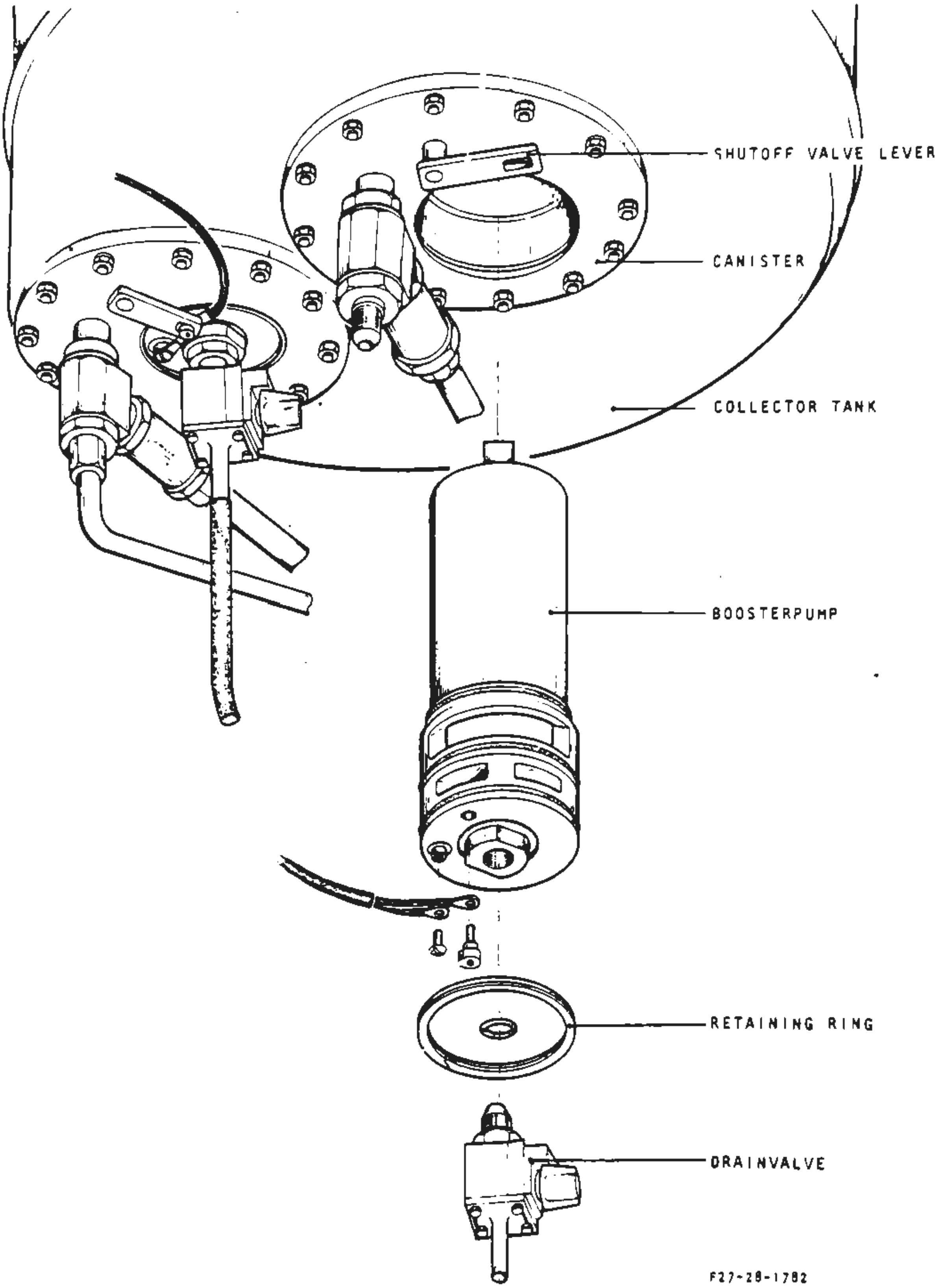
20.9 Fuel Differential Pressure Switch

Installed over the fuel flow transmitter, fuel heater and fuel filter is a fuel pressure differential switch which senses the pressure difference via sensing lines. When the pressure differential reaches 3 psi contact closes an electrical circuit to an amber caution light on the RH overhead panel.
The differential pressure switch is located on the rear side of the fire end.

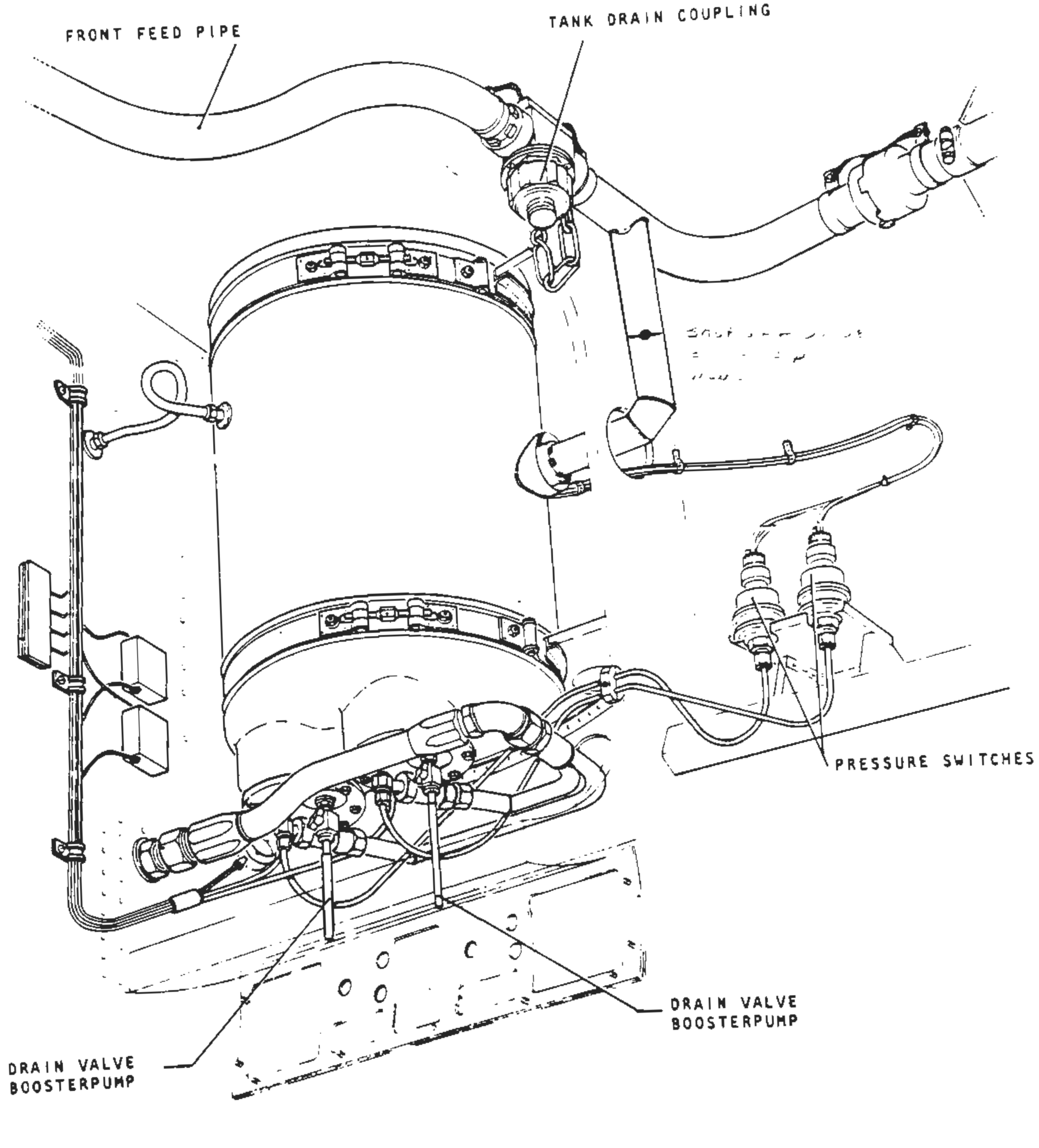
20.10 RECIRCULATION DRAIN SYSTEM

Fuel of the open drains of the engine fuel system is collected in a collector drain box (see chapter 72.00). The collected fuel is recirculated into the fuel supply system by means of a fuel driven jet pump.
Fuel pressure to operate the jet pump is taken from the fuel manifold.
The collector drain box is continuously drained whenever boosterpump pressure is available.

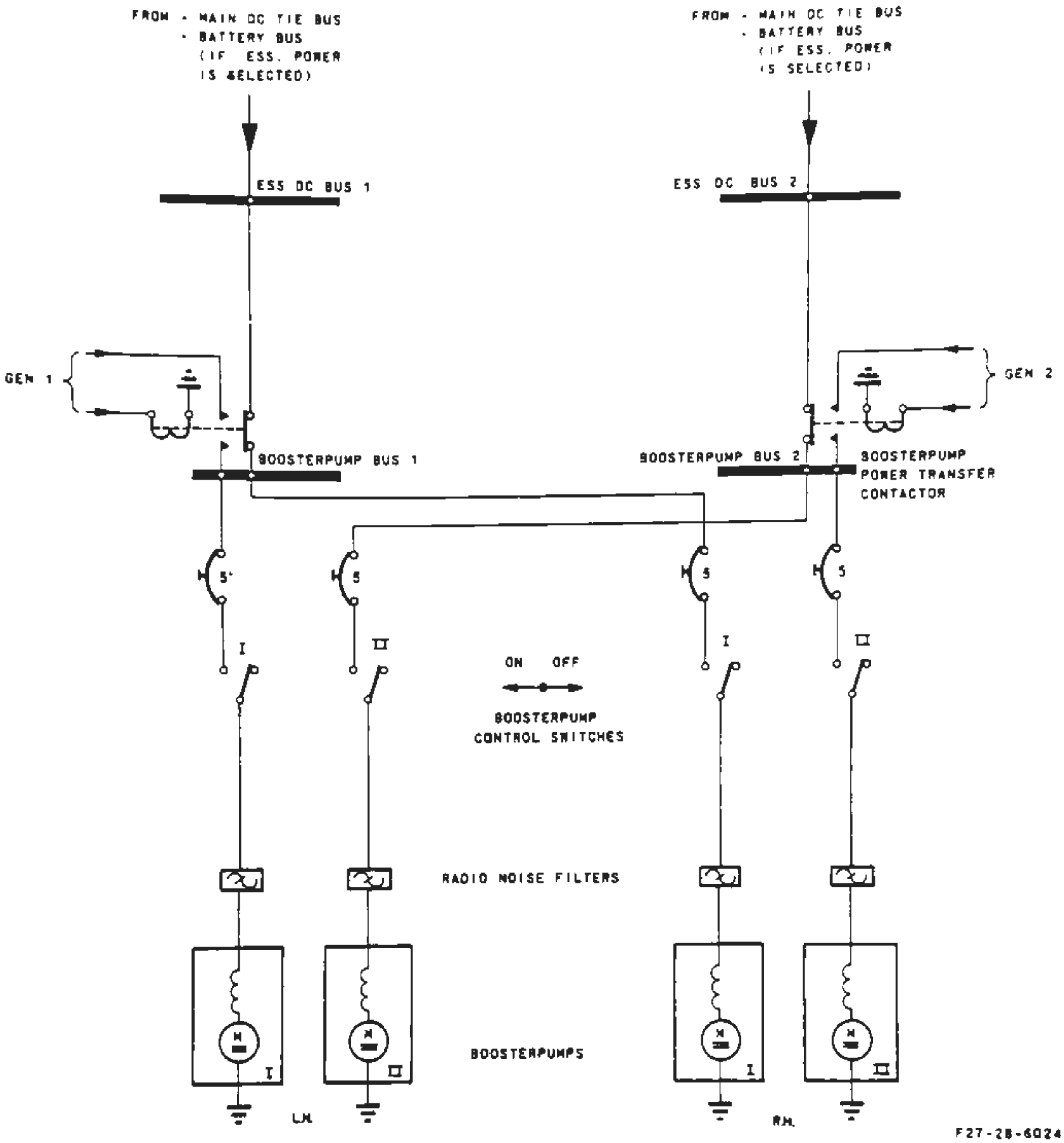
Inside the jet pump the fuel is accelerated by means of a nozzle. This acceleration creates the underpressure used to empty the collector drain box.
The contents of the collector drain box is returned to the inlet of the collector tank.
The check valve upstream of the jet pump prevents reversed flow to the collector drain box when boosterpump pressure is not available.



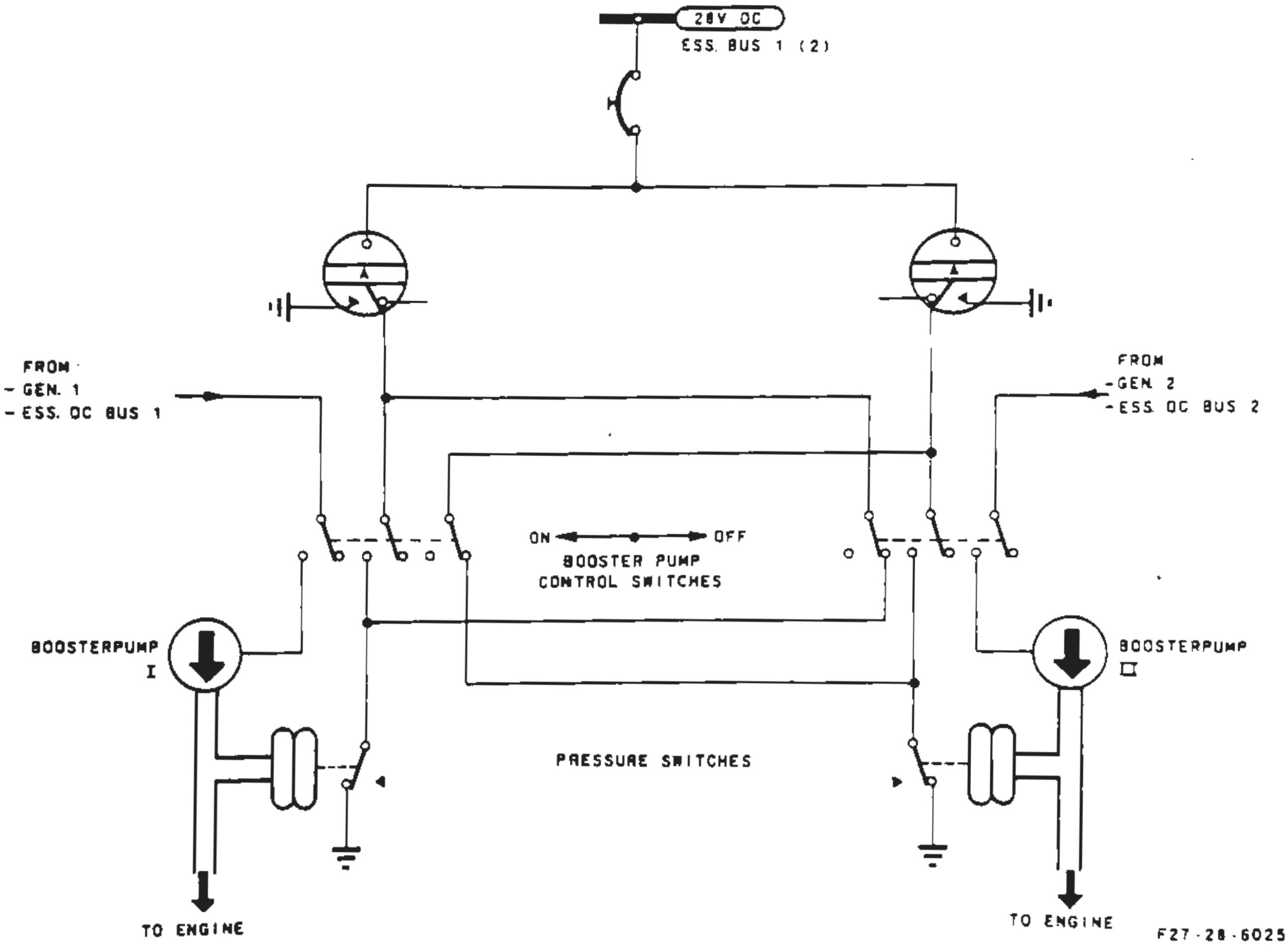
INSTALLATION OF BOOSTERPUMPS IN COLLECTOR TANK



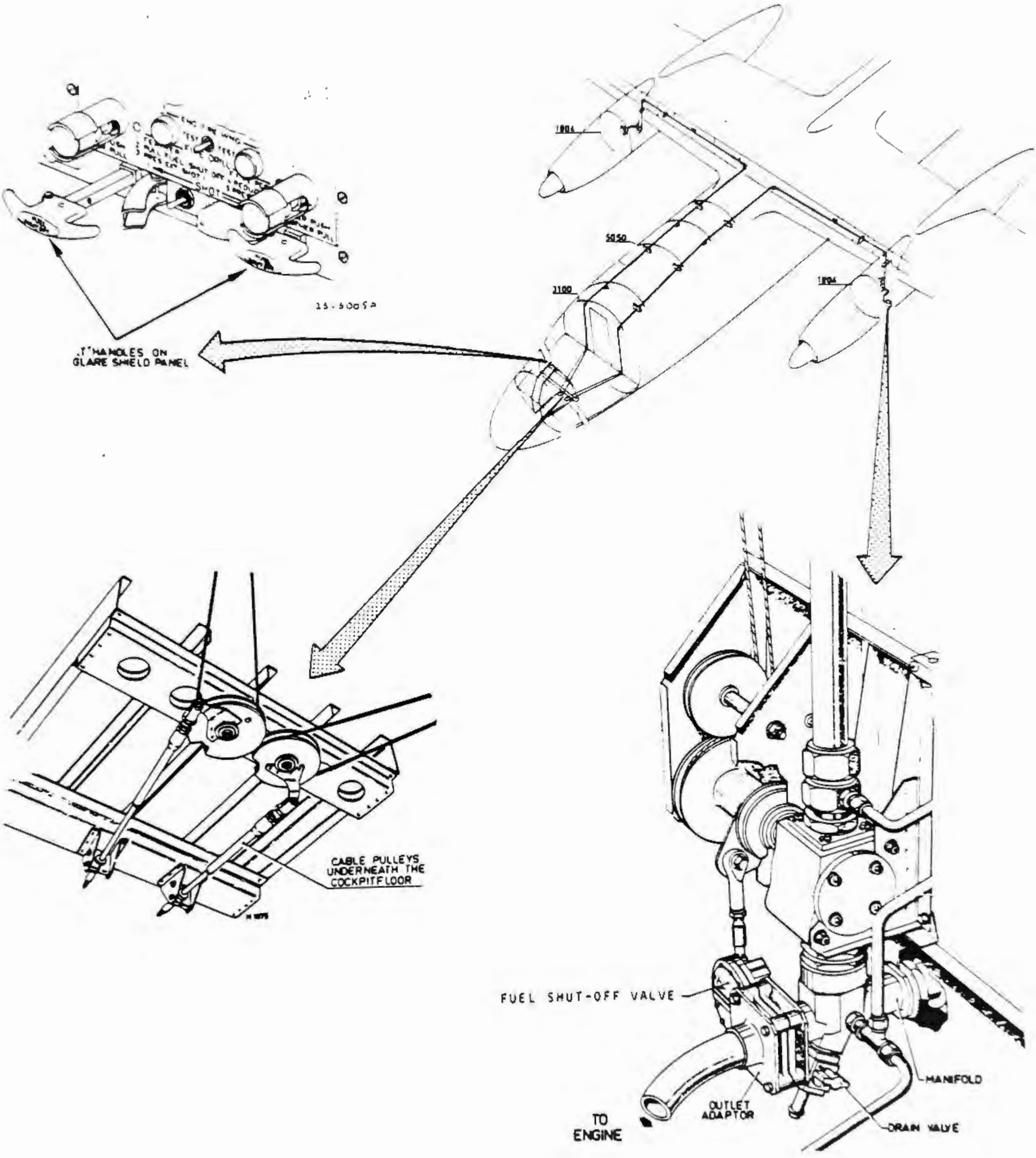
FUEL SYSTEM COMPONENTS BEHIND FIRE WALL



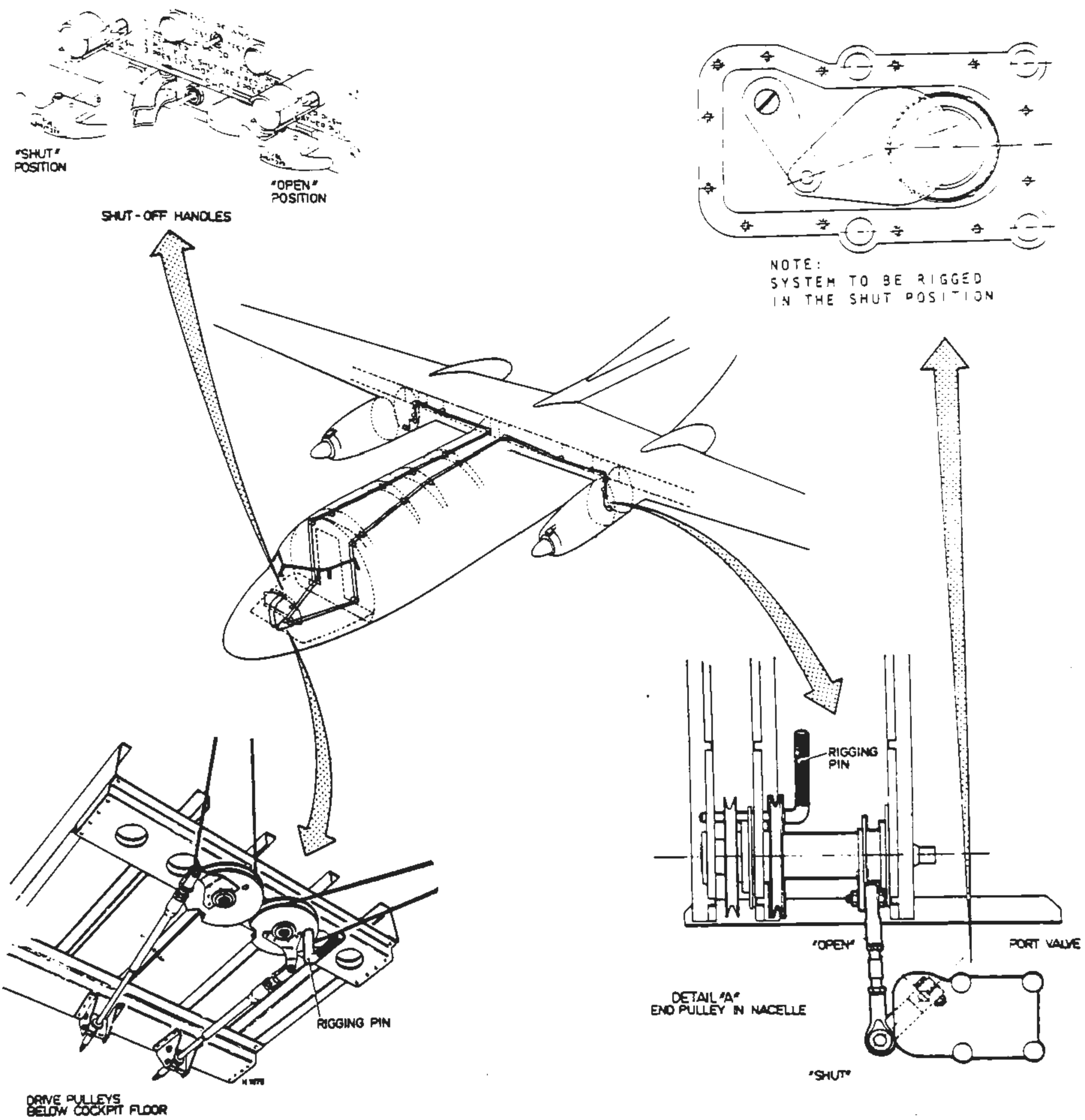
BOOSTERPUMP CONTROL SYSTEM



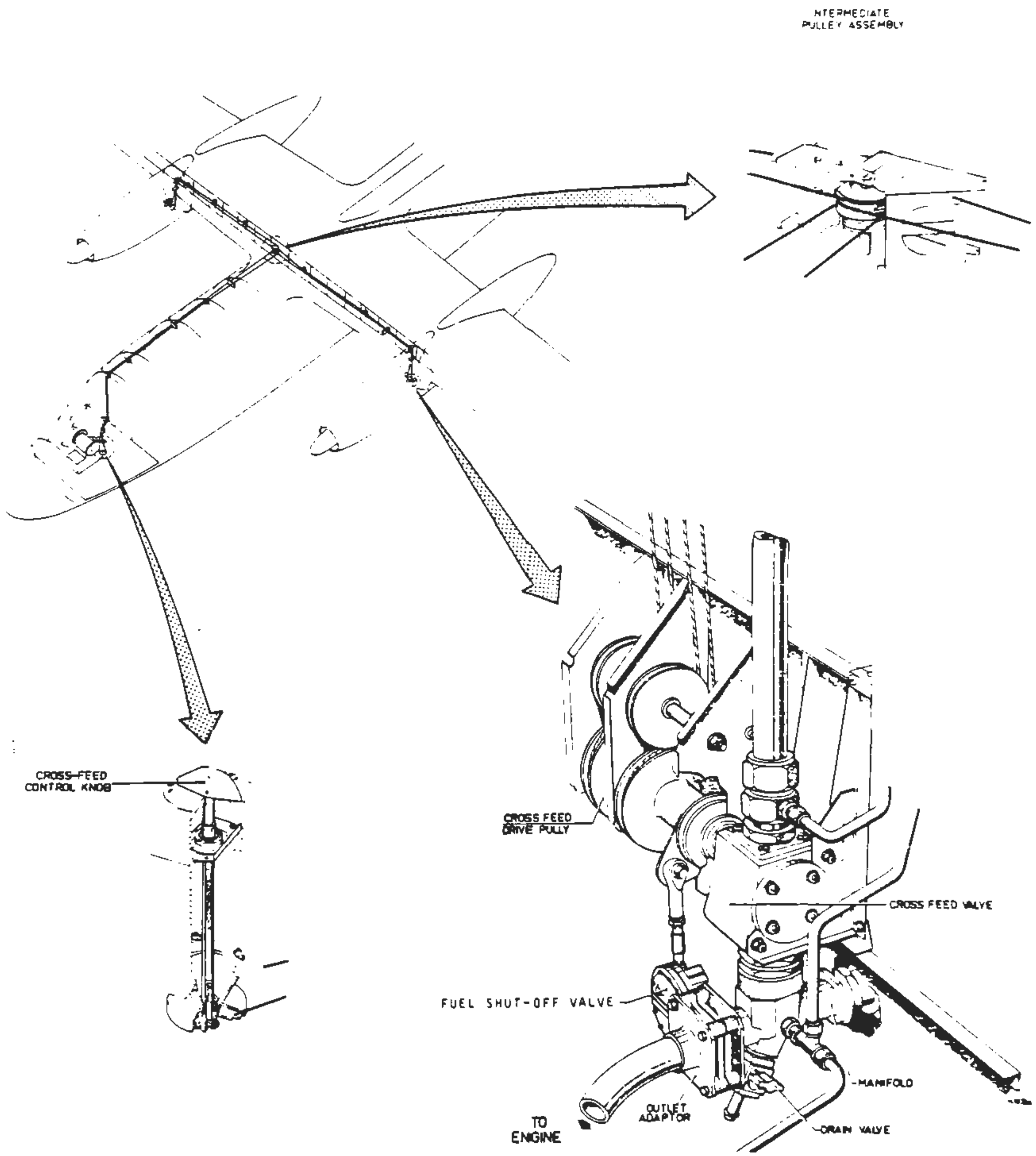
BOOSTERPUMP PRESSURE WARNING SYSTEM



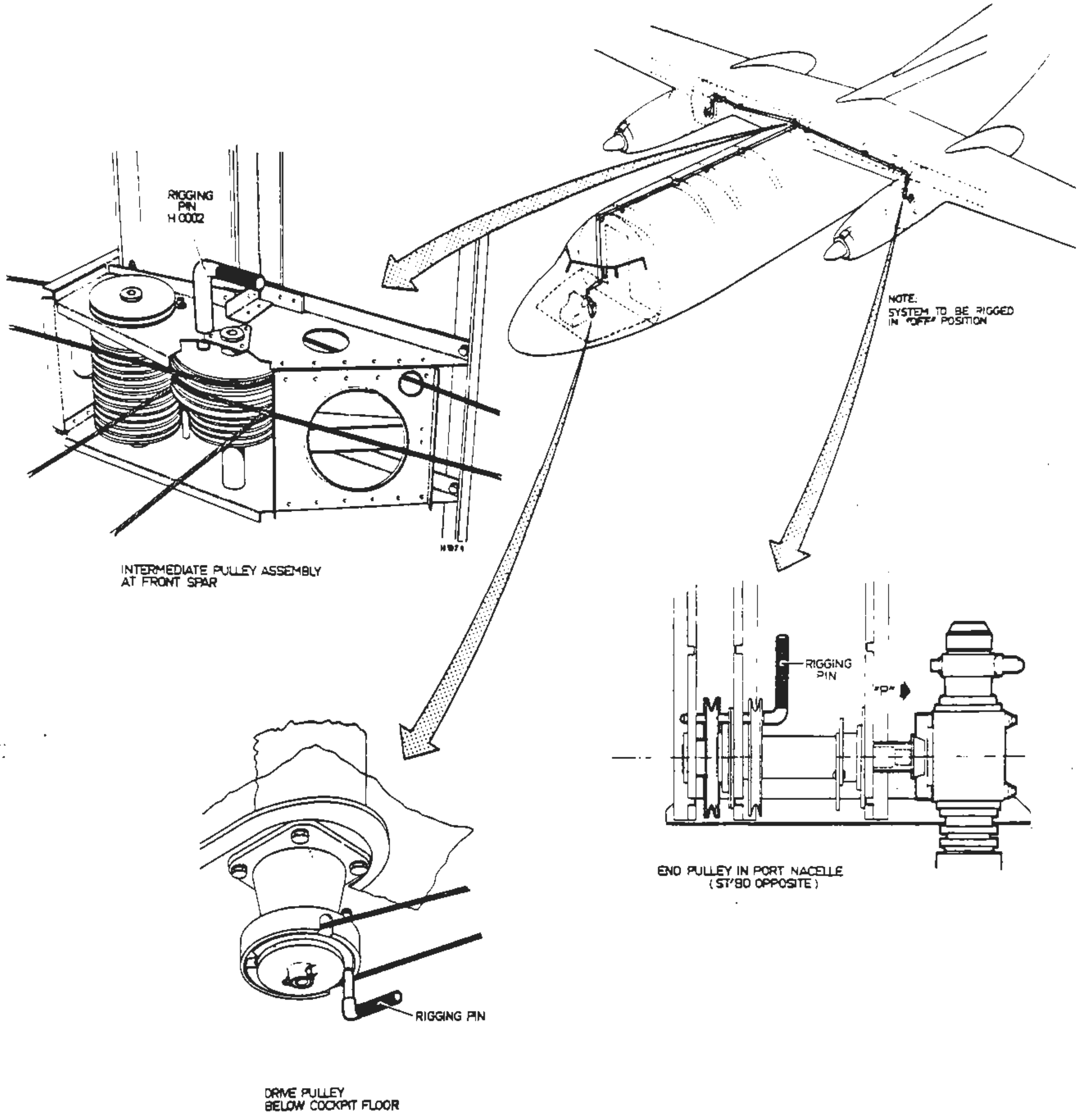
FUEL SHUT-OFF CONTROL SYSTEM



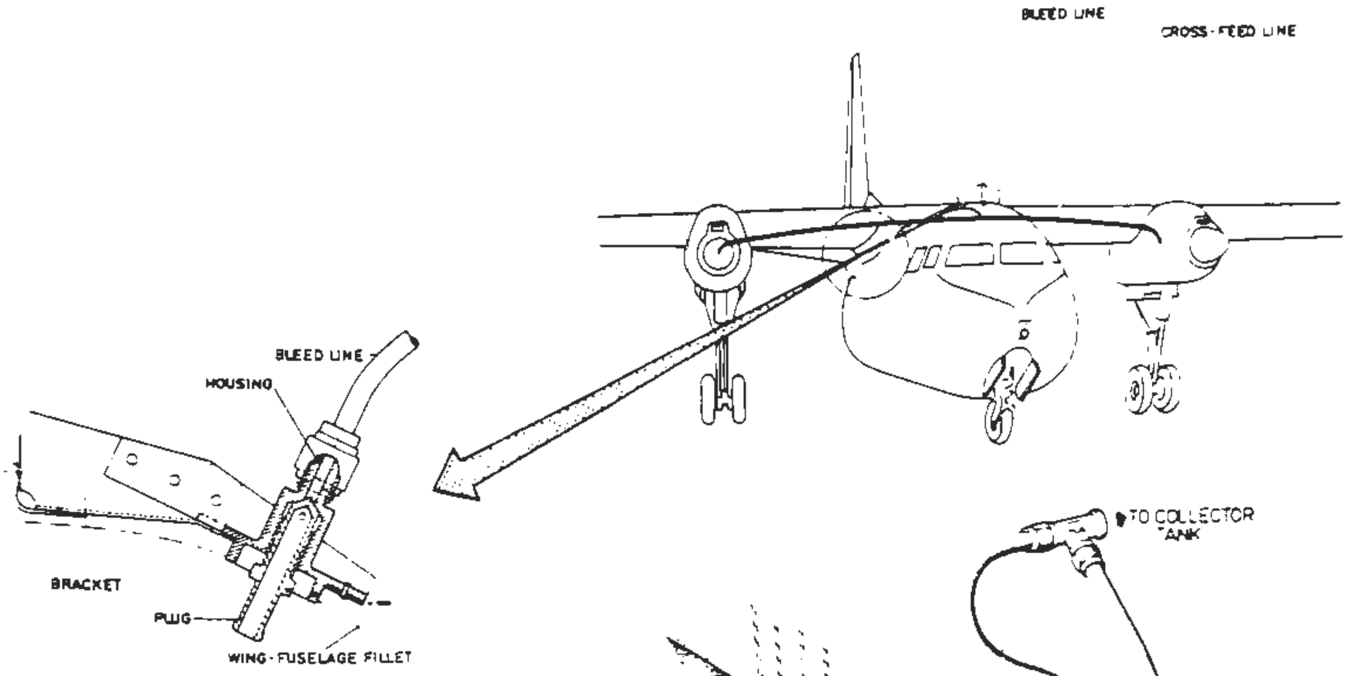
ADJUSTMENT OF FUEL SHUT-OFF VALVE CONTROL SYSTEM



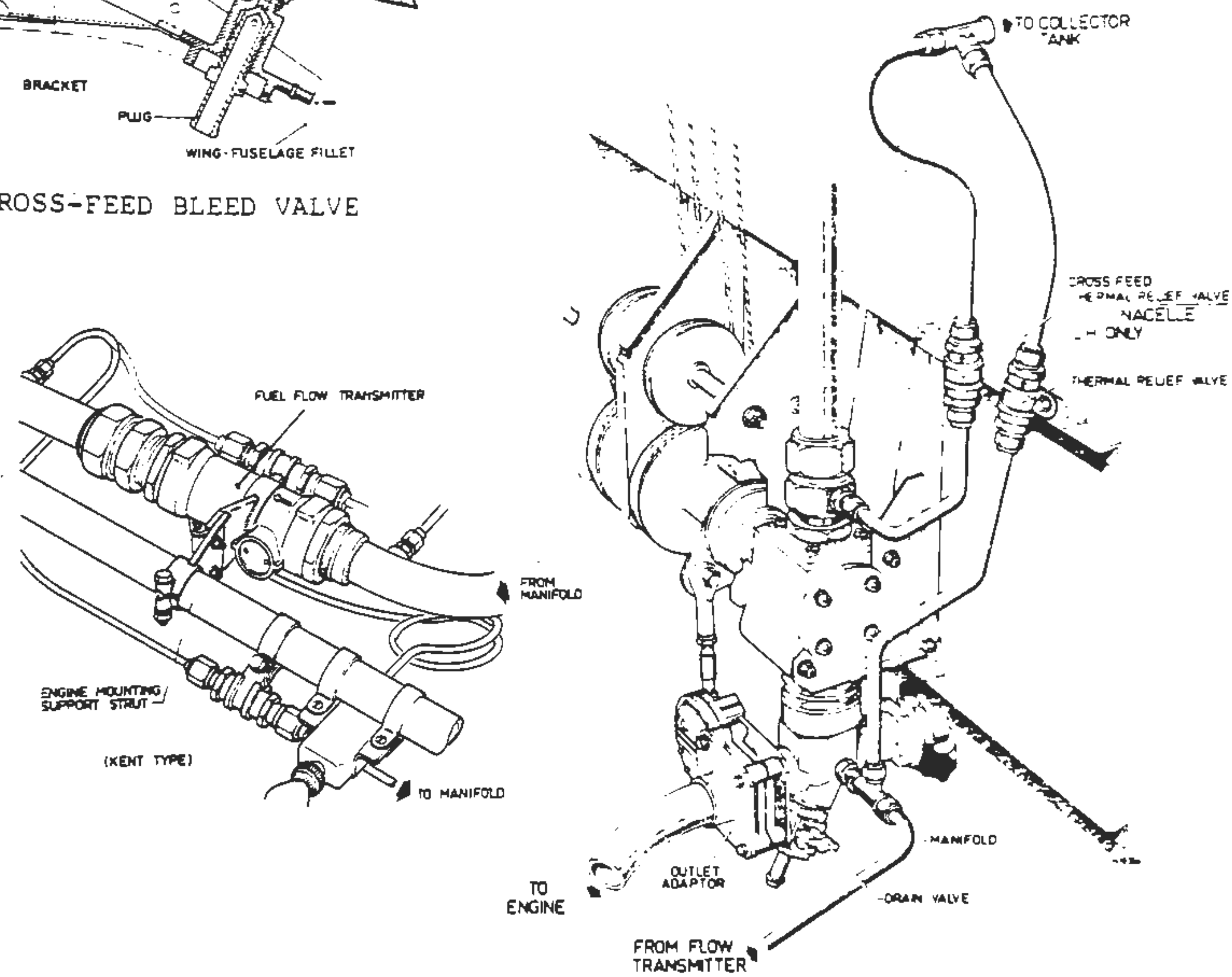
FUEL CROSS-FEED CONTROL SYSTEM



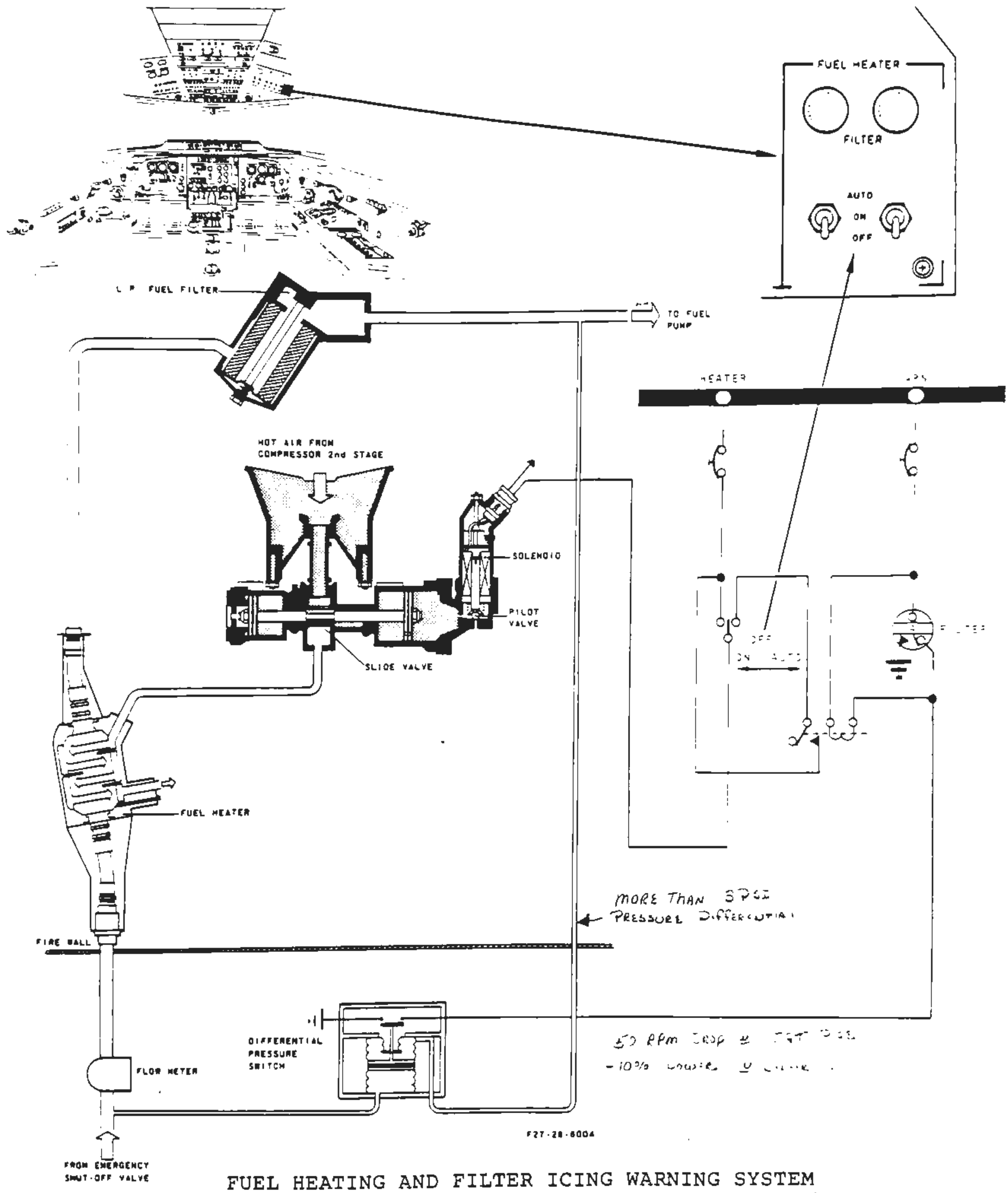
ADJUSTMENT OF CROSS-FEED CONTROL SYSTEM



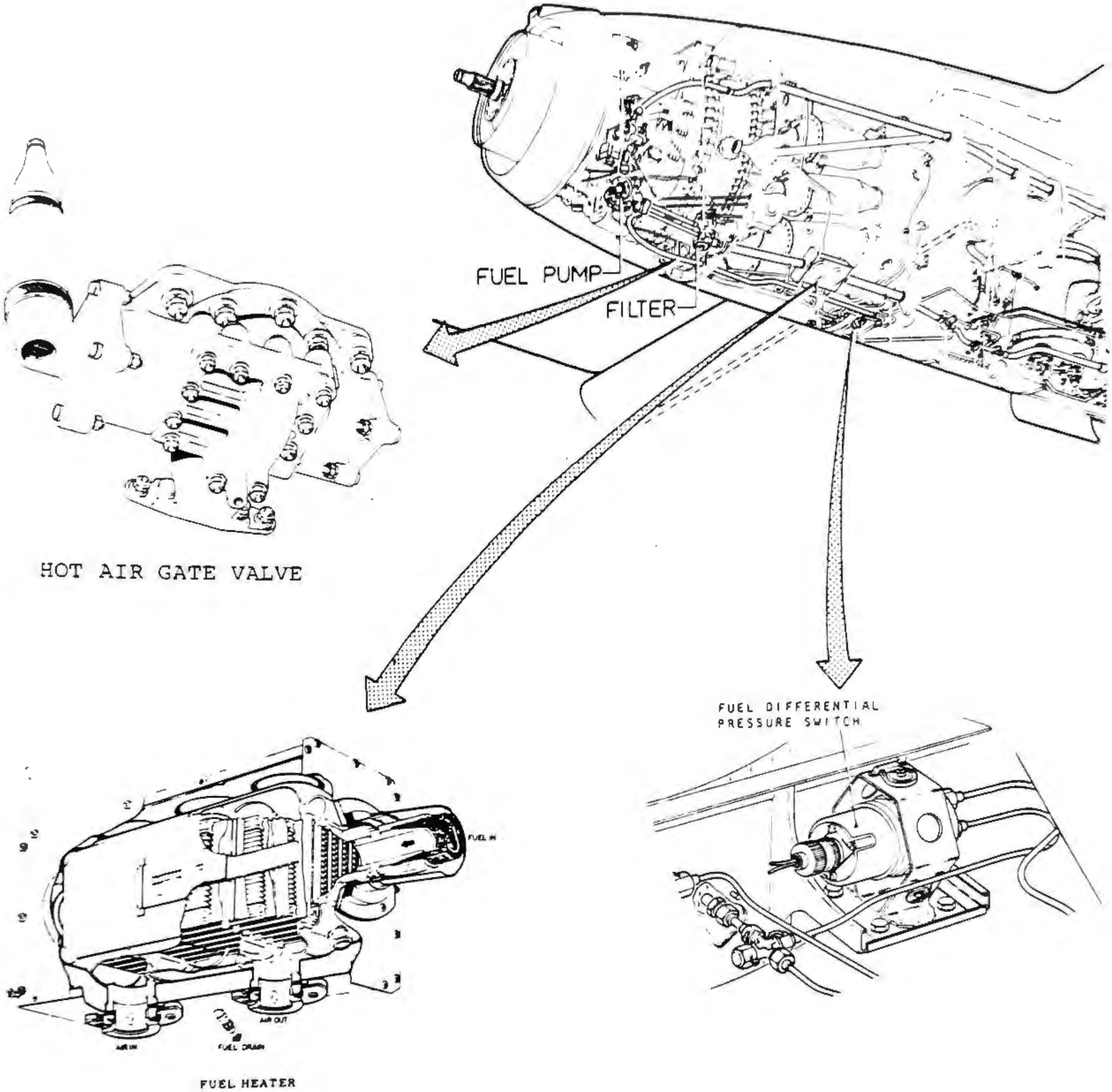
CROSS-FEED BLEED VALVE



THERMAL RELIEF VALVES AND CROSS-FEED BLEED VALVE



FUEL HEATING AND FILTER ICING WARNING SYSTEM



FUEL HEATING AND FILTER ICING WARNING SYSTEM - COMPONENTS

22.0 PRESSURE REFUELLING AND DEFUELLING

The pressure re/defuelling system consists of a pressure fuelling adaptor, two shut-off valves, two electrical and manually operated dual pilot valves and a fuelling control panel.
The maximum refuelling pressure is 60 psi at a flow rate of 570 L/min (150 US gallon/min, 125/imp gallon/min) for defuelling, the suction applied should not be more than 7 psi giving a flow rate of 225 l/min (60 US gallon/min, 50 imp. gallon/min.)

22.1 Pressure Fuelling Adaptor

The single point pressure fuelling adaptor is located in the aft section of the RH nacelle just forward of the water/methanol tank.
The adaptor is of the international standard 2,5 inch bayonet self sealing type.
The adaptor consists of a housing containing a locking flange, a receiving valve and a dust cap, which is locked on bayonet lugs on the locking flange.
The top of the locking flange forms the seat for the spring-loaded closed receiving valve.
The adaptor housing incorporates a drain valve to drain the adaptor and the refuelling line after refuelling.

22.2 Shut-off Valve

The shut-off valve is located in each main tank on the inboard side wall of the tank.
The shut-off valve contains a primary and a secondary diaphragm chamber. A drilled passage interconnects the secondary chamber with the shut-off valve inlet, while the primary chamber is open to the inlet through an orifice in the centre of the primary diaphragm. Two sensing line connections, one for each chamber, are provided on top of the valve one is connected to the dual pilot valve, the other one is connected to the main tank via a check valve. Whenever the sensing line is closed during refuelling the shut-off valve is closed due to the pressure acting on the different areas on both sides of the diaphragm. During defuelling the shut-off valve is open whenever a suction is applied to both sides of the diaphragm.

22.3 Dual Pilot Valve

The dual pilot valve is installed at the outboard tank rib.
Two identical float-operated pilot valves are mounted side-by-side in a single housing. On each float arm a spring tends to lift the float via a lever. A de-energized solenoid, however, prevents the spring to lift the float.
The solenoid can be energized by means of a test switch located on the refuelling control panel in the RH nacelle. When operated, the float is lifted and the relevant poppet valve will close.
This action will block the sensing line, resulting in closing the shut-off valve and stopping the refuelling.
The float will also be lifted by rising fuel and therefore refuelling will also stop automatically when the tank is full.

22.4 Tank Drain Coupling

The tank drain coupling is screwed into a mounting block installed in the front feed pipe from the main tank. It is a self-sealing coupling, locked to the mounting block by a lock plate and covered by a dust cap. The dust cap is connected to the coupling by a union nut which is locked by a lock spring.
The lock spring automatically disengages when the union nut is unscrewed. Positive opening of the poppet valve in the coupling occurs when the fuel drain hose is connected.

22.5 Drain Valves

These manually operated valves, located under the boosterpumps and the manifold, are provided for water drainage but may also be used for complete draining of the aircraft fuel system.

22.6 Static Inverter

A static inverter, located on the floor in the main junction box, provides 115-V 400 Hz single phase power for the automatic fuelling system and fuel quantity indication during fuelling procedures.

22.7 Fuelling Control Panel

A fuelling control panel is mounted to the inboard side of the water/ methanol tank access panel on the lower side of the RH nacelle cone.
The electronics of the fuelling control panel are mounted on five printed circuit boards, interconnected by one integral cable loom packaged in an aluminium box.
The front lay-out of the panel is made up of the following components:

- A guarded POWER ON-OFF switch.
- A MODE switch to select either REFUEL-AUTO or MANUAL or DEFUEL MANUAL.
- Four push-button switches to preset the desired quantity of fuel for the main tanks on a 2 digit rotary switch x 100 kg lbs.
- Two guarded main tank shut-off valve switches OPEN - SHUT.
- A SHUT-OFF TEST switch to check closing of the shut-off valves.
- Two amber VALVE SHUT lights to indicate the position of the respective shut-off valve (when a light is on the shut-off valve is closed).
- Incandescent read-out displays of the LH and RH main fuel tank quantity and the LH and RH water/methanol tank quantity.

Operation

When the power switch is selected to ON DC power is transmitted from the battery bus or when external DC power is connected to the aircraft, from the ground service bus to the fuelling bus.

DC power from the fuelling bus will start the static inverter and illuminate the VALVE SHUT lights.

The 115-V AC of the static inverter is required for the main tank fuel quantity indicating system in the cockpit.
An AC output signal from the cockpit indicator is converted to a DC signal and used to drive the 4 digit quantity display on the control panel.

This indication is compared with the quantity indication as chosen by the push button rotary switch x 100 on the control panel.

When the main tank SHUT-OPEN switches are in the SHUT position the amber valve shut light will be on and the solenoids on the dual pilot valve energized (shut-off valve closed).

If the chosen quantity x 100 is more than the main tank quantity displayed, the shut-off valve will open if refuelling pressure is applied to the valve provided that the MODE switch is in the REFUEL AUTO position and the tank switch in the OPEN position. The amber VALVE SHUT light will extinguish.

When the pre-selected quantity and the main tank quantities become equal the valve control will provide a circuit for the solenoids on the dual pilot valve to lift the valve to the closed position. The increasing pressure in the sensing lines between pilot valve and shut-off valve will close the shut-off valve.
The amber VALVE SHUT light illuminates to indicate that refuelling is stopped.

If no AC power from the static inverter is available the main tanks cannot be filled in the automatic mode. Revert MODE selector to MANUAL.
Check the fuel quantity with the magnetic level indicator and stop refuelling when required by selecting the applicable tank switch to SHUT.

During the early stage of pressure refuelling the serviceability of the system can be tested by moving the SHUT-OFF TEST switch to TEST.
Refuelling should stop within 7 seconds and the amber valve shut light should illuminate.
Return test switch to OFF.

The main tanks can be defuelled by suction in DEFUEL MANUAL MODE only, down to a quantity of 150 litres.

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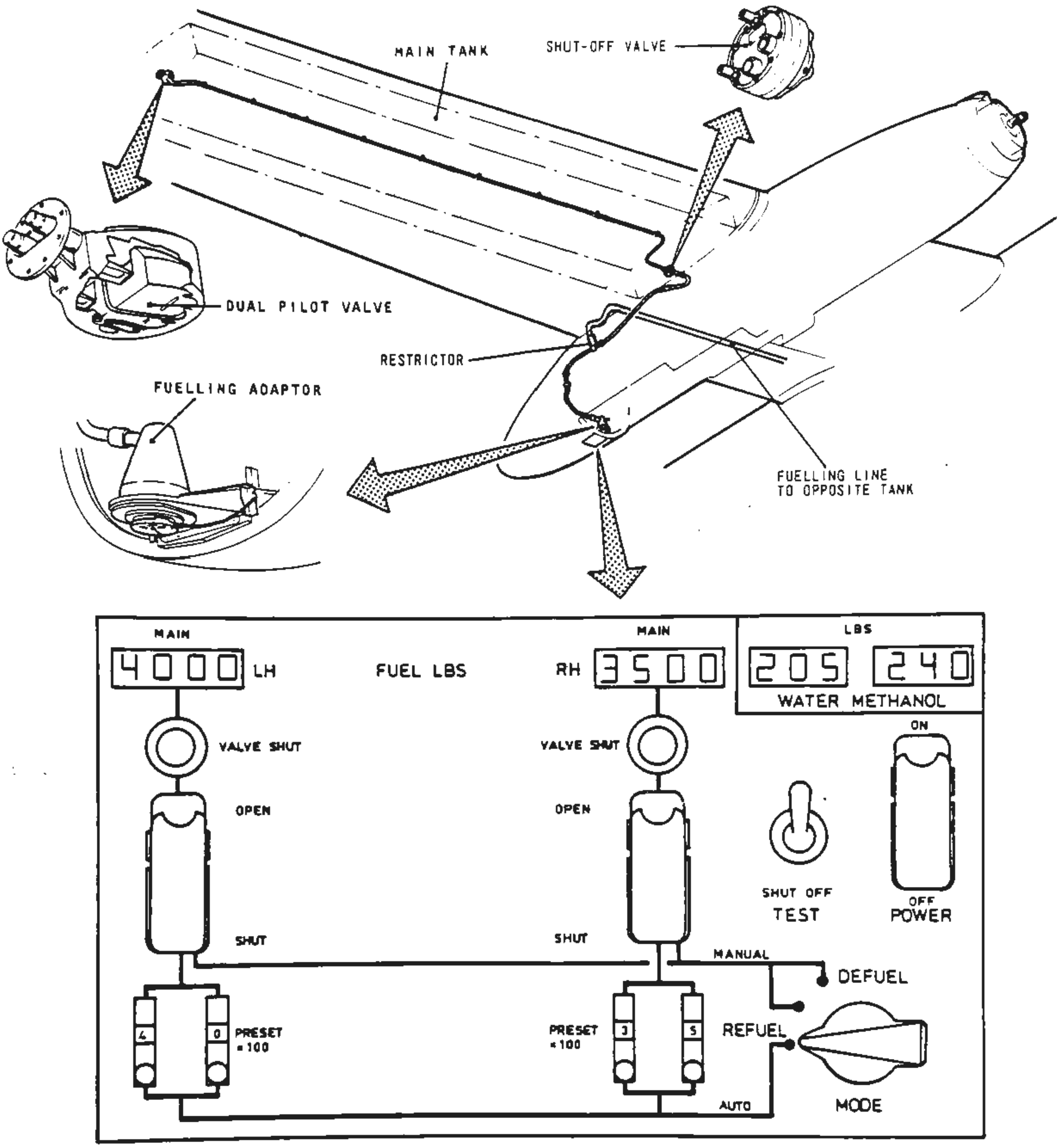
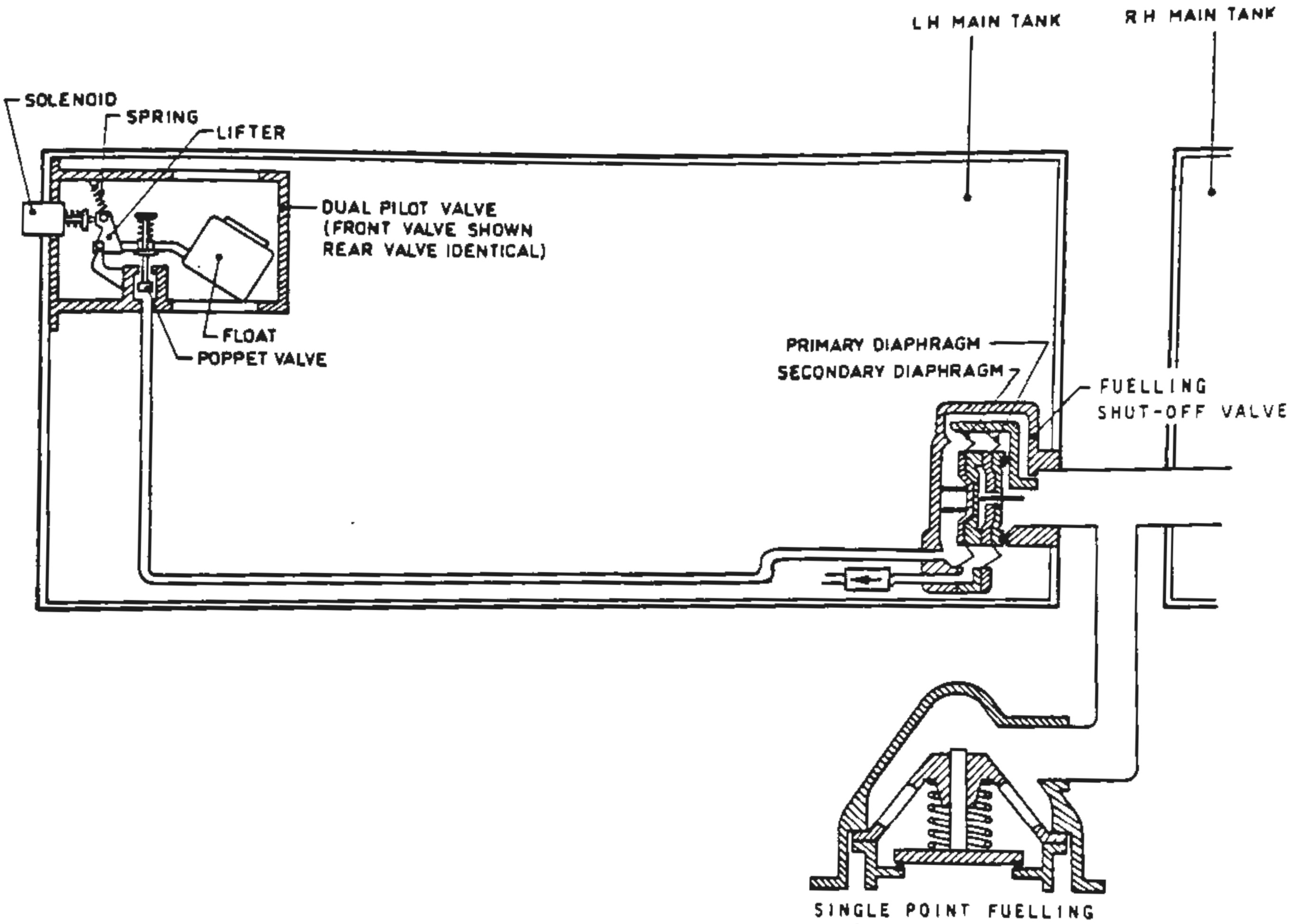
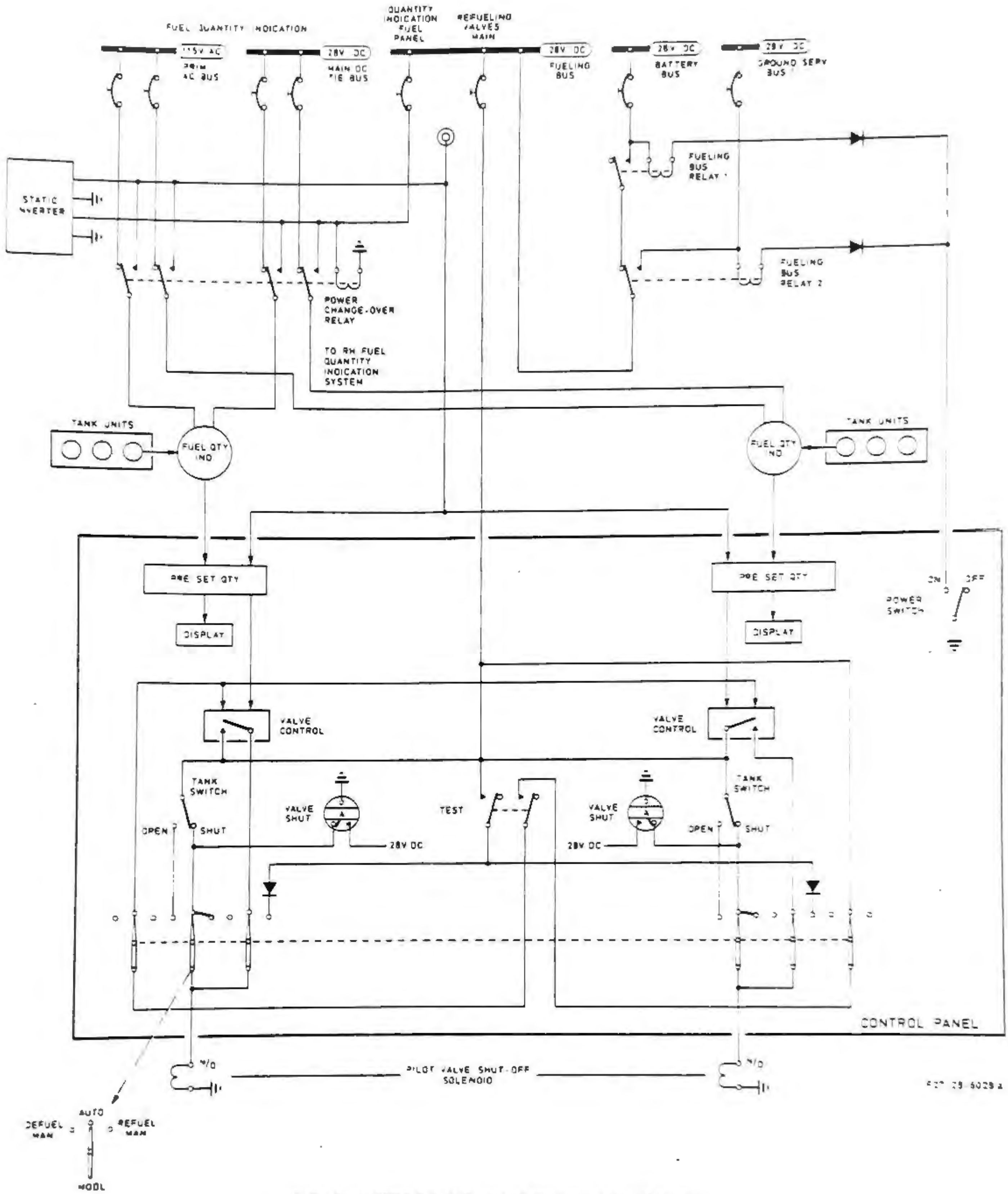


REFUELLING / DEFUELLING SYSTEM



REFUELLING / DEFUELLING SYSTEM



RE/DEFUELLING CONTROL CIRCUIT

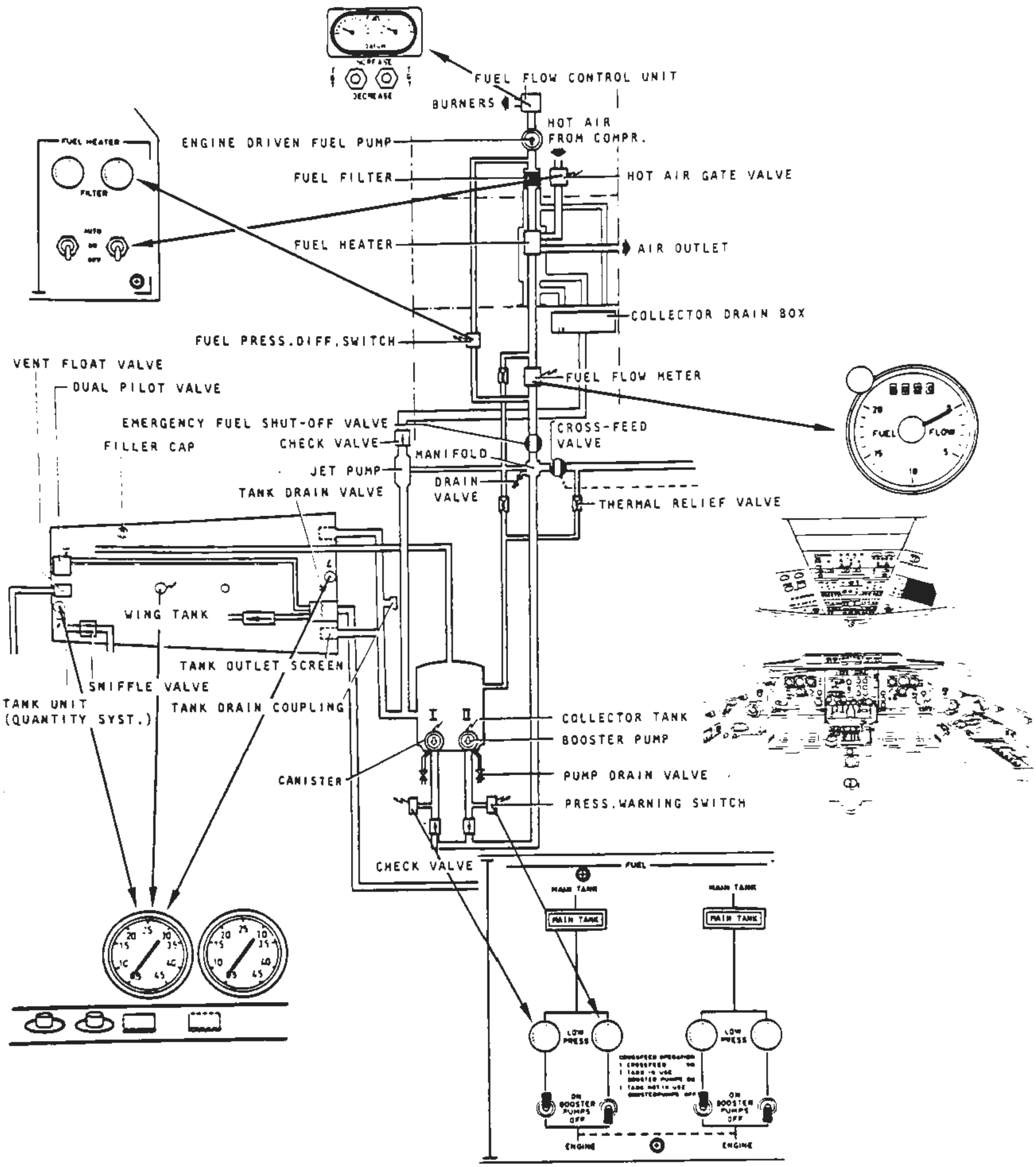
40.0 QUANTITY INDICATING

Indication of fuel quantity is given by two capacitance type fuel gauge systems, one for each main tank. Each system includes three tank units, of which the inboard unit is equipped with a compensator and a fuel quantity indicator located on the main instrument panel. The tank units utilize the dielectric properties of the fuel to obtain quantity measurements in values of capacitance. Any change in fuel quantity produces a corresponding change in electrical capacitance of the tank units. The indicator which houses a bridge circuit, amplifier and drive motor converts the tank unit capacitance into a dial presentation of measured fuel quantity. Each indicating system requires 28-volt DC and 115-volt single-phase 400 Hz AC. Two test buttons, one for each indicating system are mounted on the instrument panel. Pressing of the test button will cause the indicator pointer to turn towards .9.

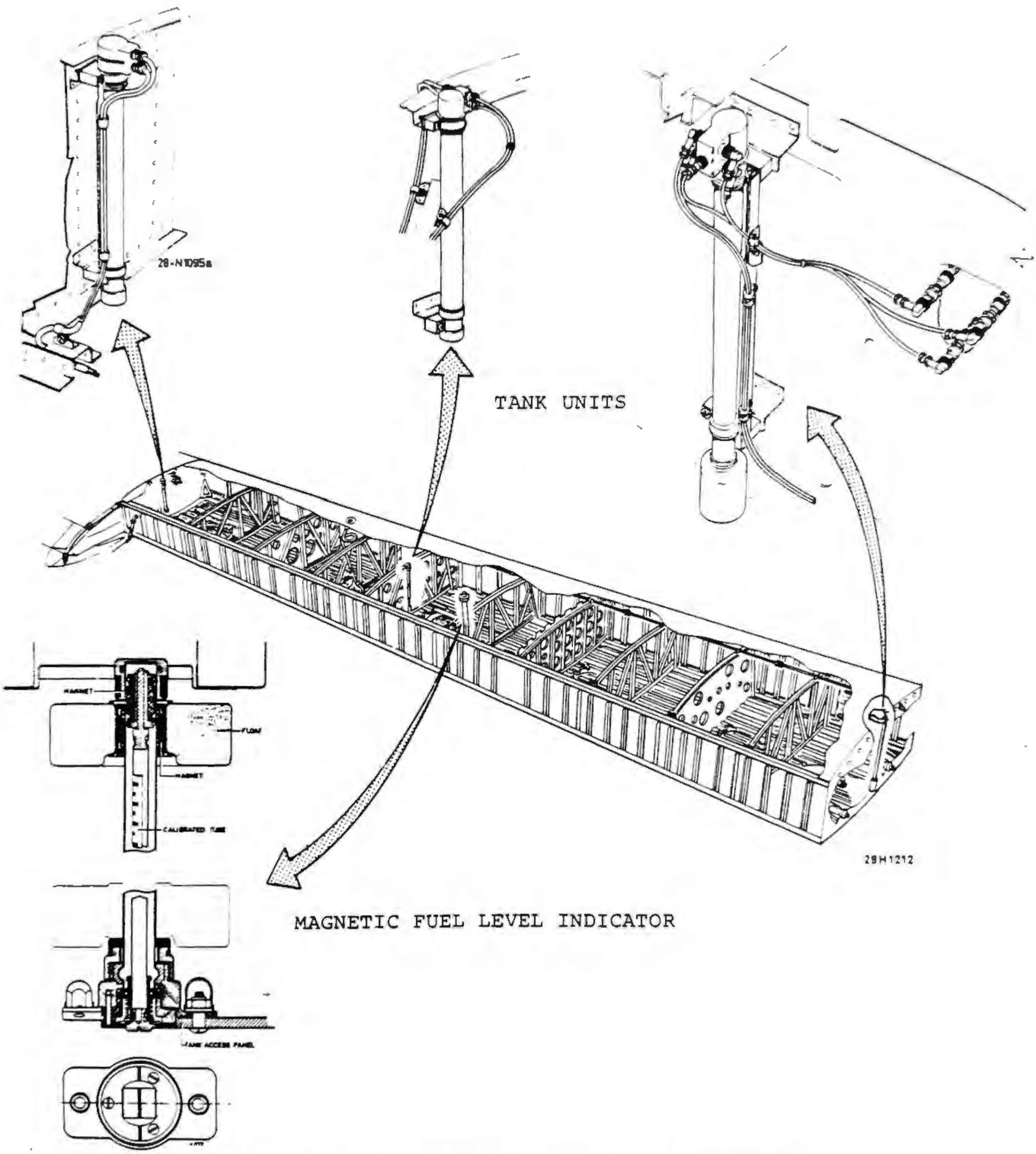
40.1 Magnetic Fuel Level Indication

Beside the indication of fuel quantity in the cockpit, the fuel quantity can also be checked outside the aircraft by means of a magnetic fuel level indicator in each main tank. This indicator is accessible via the lower surface of the wing and consists of a calibrated tube magnetically linked to an internal float. To check the fuel level, the calibrated tube must be pushed in and turned 90 degrees. Then slowly lower the tube until it links to the magnet in the float and the fuel quantity can be read in terms of volume using the lower edge of the base fitting as a reference.

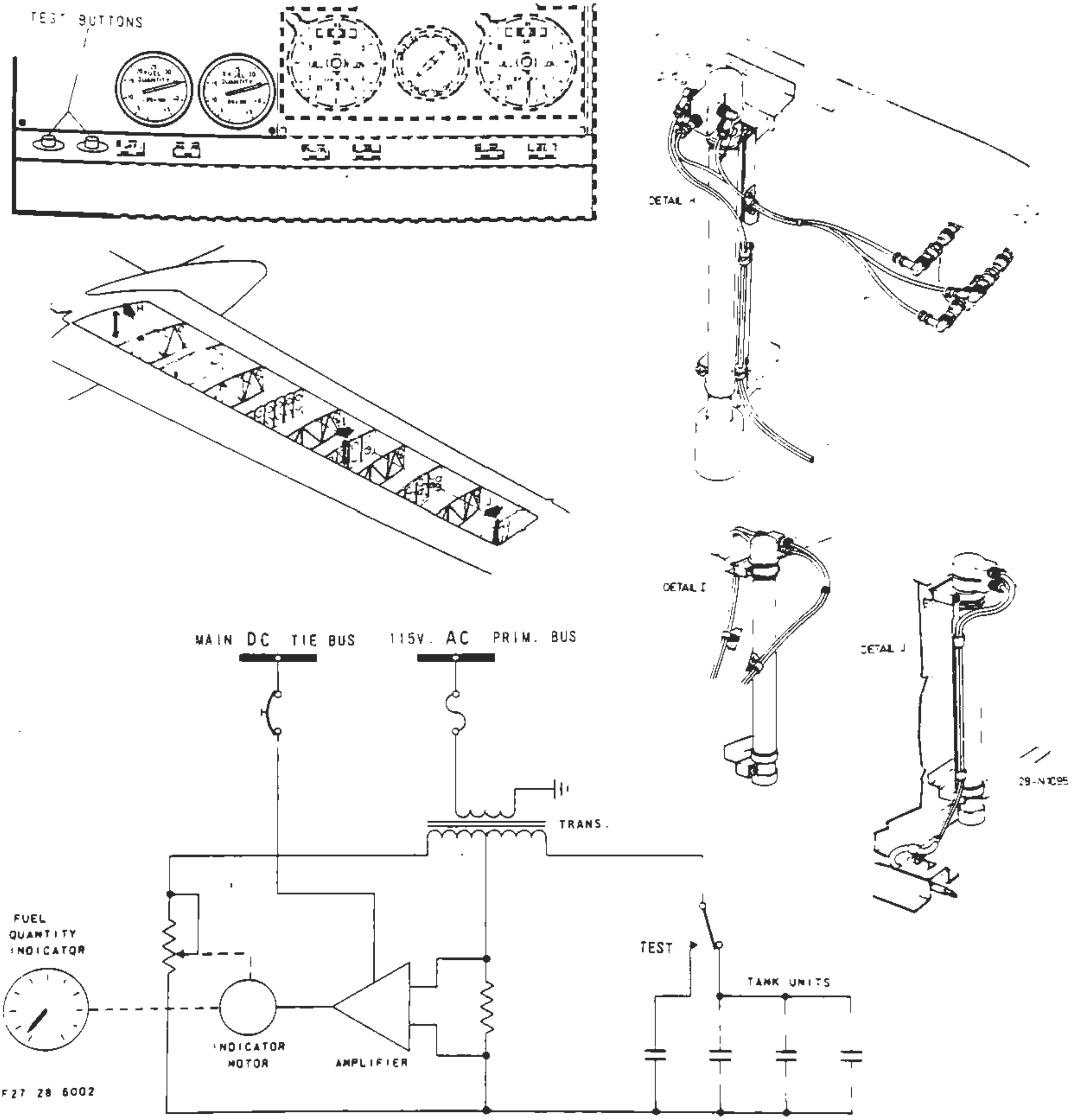
END



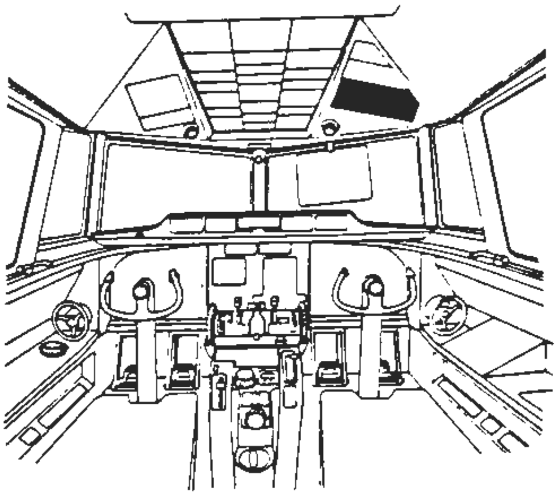
.FUEL SYSTEM INDICATIONS

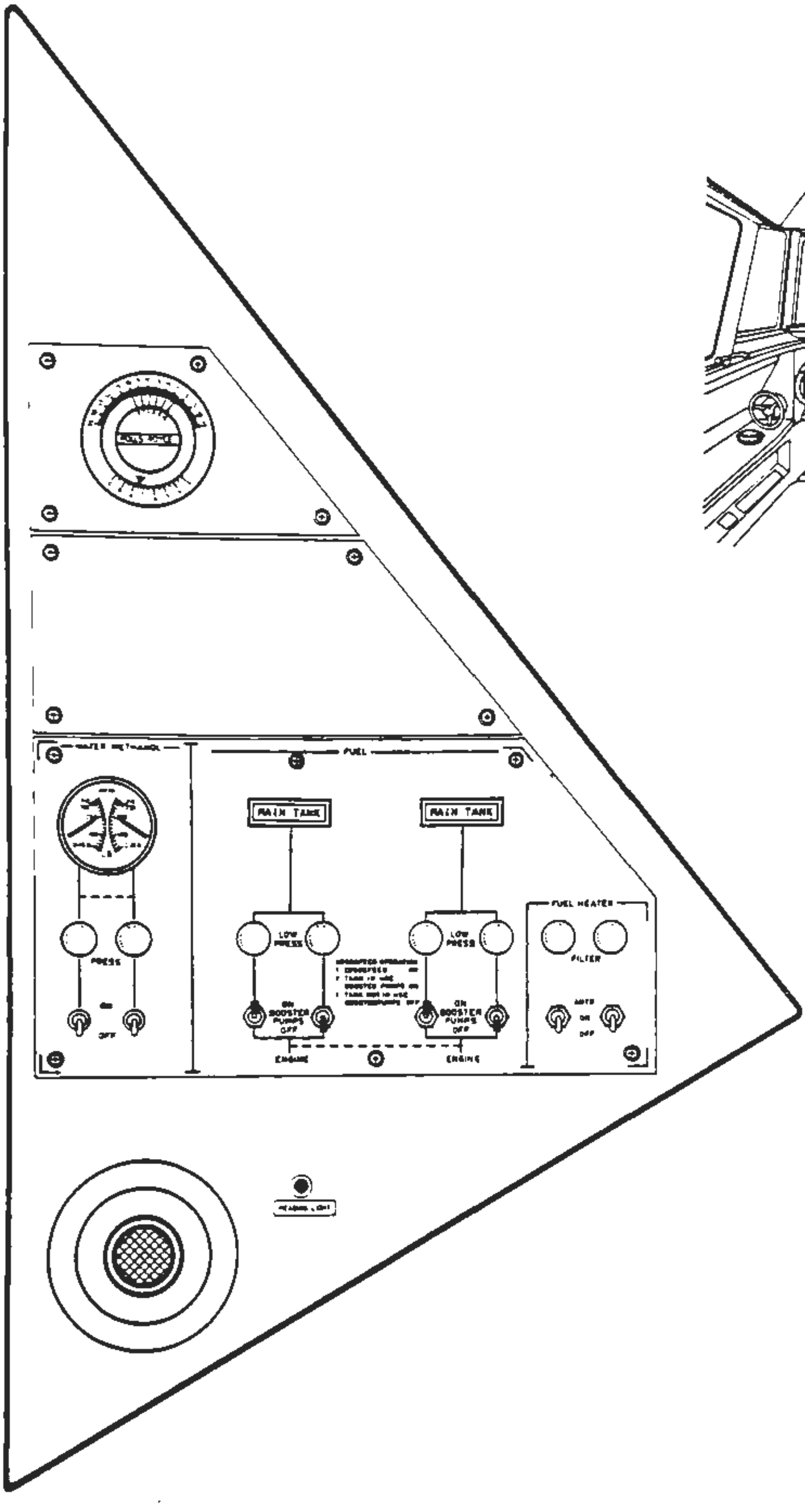


FUEL QUANTITY INDICATION SYSTEM - COMPONENTS

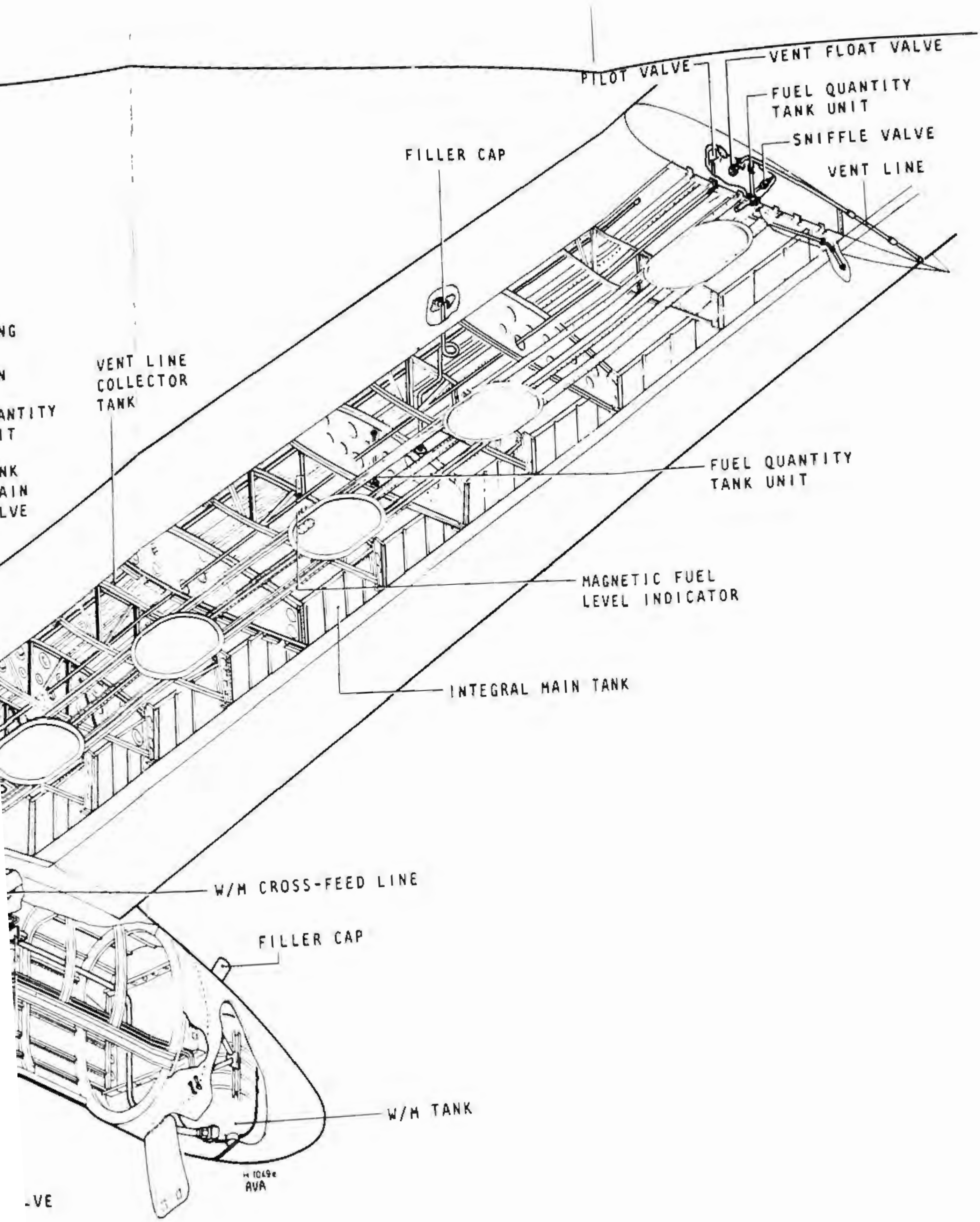


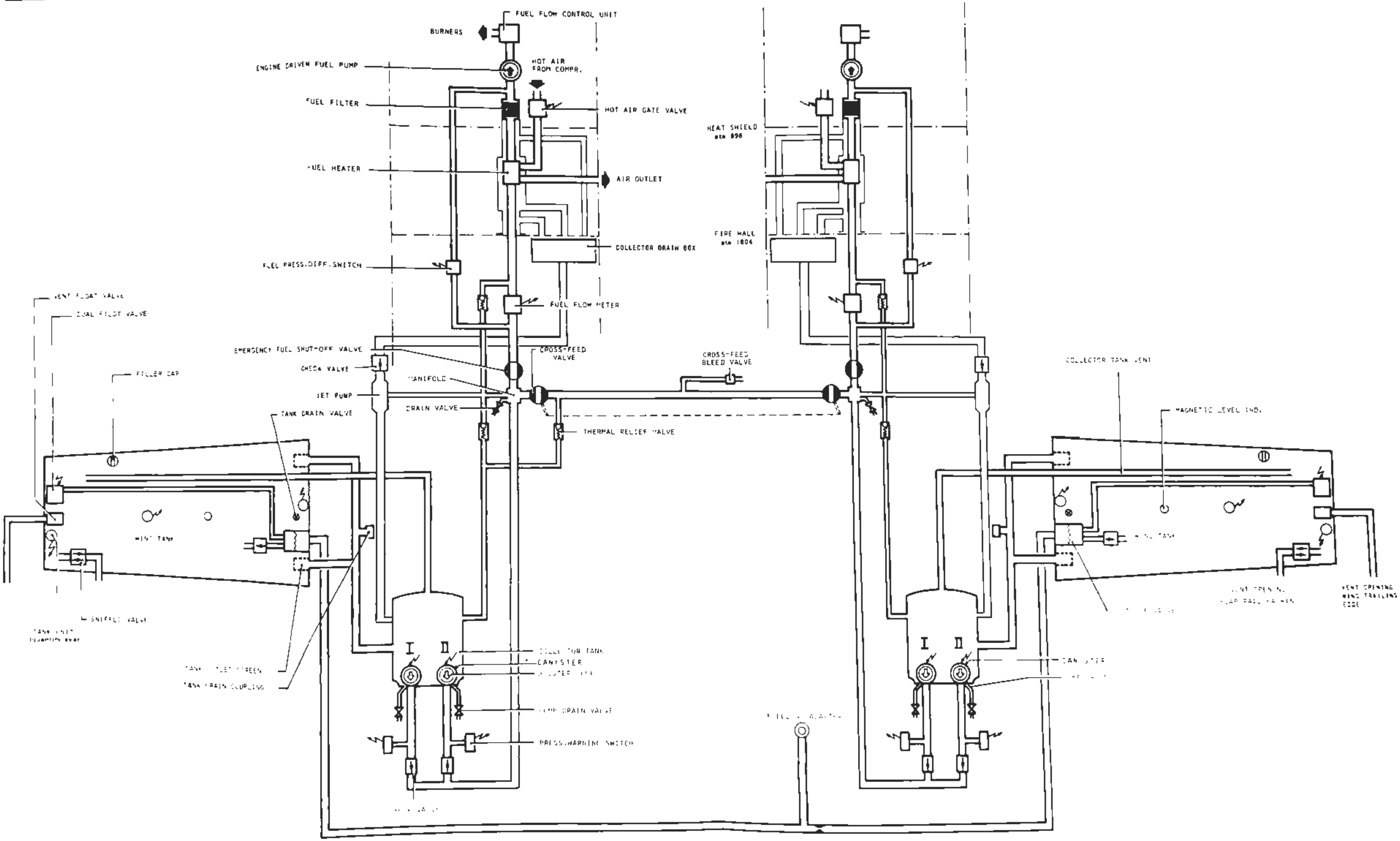
FUEL QUANTITY INDICATION SYSTEM





FUEL AND W/M SYSTEM CONTROLS ON RH OVERHEAD PANEL


PILOT VALVE
VENT FLOAT VALVE
FUEL QUANTITY
TANK UNIT
SNIFFLE VALVE
VENT LINE
FILLER CAP
VENT LINE
COLLECTOR
TANK
FUEL QUANTITY
TANK UNIT
MAGNETIC FUEL
LEVEL INDICATOR
INTEGRAL MAIN TANK
W/M CROSS-FEED LINE
FILLER CAP
W/M TANK
H 1049e
AVA



FUEL SYSTEM DIAGRAM

28. FUEL SYSTEM

28. FUEL SYSTEM

00.0 GENERAL

This chapter deals with the fuel system of the F27. The engine systems are not covered, but for a general description reference is made to chapter 73 POWER PLANT and for more details to the Rolls Royce Manuals.

The F27 fuel system can be divided into two identical independent systems, one for each engine. However, in case of emergency, crossfeeding is possible. Each system comprises fuel storage, ventilation, re/defuelling, fuel supply and fuel quantity indication.

Fuel Storage

Fuel is stored in two integral main tanks one in each outer wing torsion box and in two collector tanks one in each nacelle. On customer request pylon tanks and/or inboard tanks may be fitted.

Ventilation

The collector tank vents into the main tank via an open ventline. Ventilation of the main tank takes place via an outlet on the lower side of the outer flap fairing. In case this ventilation opening is blocked, a sniffle valve can relieve positive or negative pressures in the tank.

Re/defuelling

Re/defuelling of the main tanks is accomplished through a single point pressure re- and defuelling system via a fuelling adapter in the RH nacelle.
If pressure refuelling cannot be accomplished each main tank can be filled via an overwing filler cap located in the top surface of the wing near the end of the tank.
If no suction source is available defuelling may be carried out via an additional drain coupling located in the supply line from the main tank to the collector tank.

Fuel Supply

Fuel is supplied via two independent systems to the left-hand and the right-hand engine. The systems are interconnected by a crossfeed line and each system is capable of delivering fuel to one or both engines.

Fuel Quantity Indication

A capacitance bridge type quantity indication system is installed to give an indication of the fuel quantity.
On the main instrument panel in the cockpit a fuel quantity indicator is located which receives a signal from three quantity units in the main tank. The reading of the indicator includes collector tank capacity and is given in terms of weight. Each indication system can be tested by means of a test button located close to the indicator.

In addition a magnetic fuel level indicator is installed on the lower surface of each main tank, to measure the fuel quantity from outside the aircraft. The indication includes collector tank capacity and is given in terms of volume.

END

82 WATER INJECTION

82. WATER/METHANOL SYSTEM

82. WATER/METHANOL SYSTEM

00.0 GENERAL

To boost or restore the power loss, due to operation under high ambient temperatures, the engines are equipped with a water/methanol system. The water cools the air thereby increasing the mass airflow while the methanol serves as an extra fuel.
The mixture is injected in the first compressor stage and the amount of injected water/methanol is controlled by a water/methanol control unit. The control unit is linked to the relevant rpm lever to ensure that water/methanol is available at take-off rpm.
Use of the water/methanol system is limited up to maximum 10,000 ft or between -30° C and ISA + 35° C.

The aircraft water/methanol system consists of two systems interconnected by an open crossfeed line to enable the pump of one system to feed both engines when the other pump fails. The system comprises a water/methanol tank in which an electrically operated water/methanol pump is installed, an electrically operated shut-off valve, a filter and a pressure switch.
A check valve downstream of the pump prevents a reverse flow of water/methanol. A small drilling in the check valve and a thermal relief valve relieve thermal pressure in the system.

The system is controlled by a control switch on the RH overhead panel. Switching to ON will get the pump in operation, opens the shut-off valve and arms the pressure switch. Whenever the pressure is above 12 psi the pressure switch will be closed and a green pressure indication light will illuminate. When a propeller is feathered, the shut-off valve will close automatically and the relevant pressure light extinguishes but the water/methanol pump on the affected side remains running and is standing by for the other system.

10.0 STORAGE AND DISTRIBUTION

10.1 Water/Methanol Tank

A stainless steel water/methanol tank is installed in the rear part of the nacelle and has a capacity of 150 liter. The quantity in the tank can be checked by means of a dipstick on top of the tank or by reading the dual quantity indicator in the cockpit which is connected to the tank unit in the tank. By means of a filler cap on top of the tank gravity filling is possible while a pressure replenishing unit is installed in the bottom of the tank. To indicate when the tank is filled up to max. an overflow line and valve are incorporated.During pressure filling the valve must be open. Any spillage of water/methanol during gravity filling will be drained via a tray and drain line to an outlet on the rear inboard side of the nacelle. Close to the drain outlet a screened vent outlet is installed for ventilation of the water/methanol tank.
The tank can be drained by means of the drain valve below the pump or via the pressure filling coupling.

10.2 Water/Methanol Pump

The water/methanol pump is a centrifugal type electrically driven submerged pump, fitted to the bottom of the tank. A motor seal drain line is connected to a nipple, screwed into the pump base. The tank drain valve is screwed into the centre of the pump cover. The impeller is mounted directly on the armature shaft of a 24-28 V DC motor with a seal between motor and pump. The fluid enters the impeller housing via a screen on the lower side of the pump. A discharge elbow is attached to the pump base by a long bolt. The external wiring is connected to the HIGH and COMMON terminals of the radio noise filter. The LOW terminal is not used.

10.3 W/M Shut-off Valve

This electrically operated slide valve is located in the water/methanol supply line. The valve assembly consists of a valve body with a movable slide and an electric actuator. When energized, the actuator operates a crank within the body of the valve, thereby moving the slide to the open or closed valve position. The actuator, bolted to the valve body, consists of a 24-V DC motor, driving a reduction gear, the movement of which is stopped by limit switches in the extreme positions.

10.4 W/M Filter

The filter is located downstream of the shut-off valve. In the outlet adaptor a pressure warning switch is fitted. The filter consists of a head casting with inlet and outlet ports, a felt filter element and a metal element housing. The element housing and head casting are bolted together with a centre bolt. A drain valve is screwed into the bottom of the housing.

10.5 Thermal Relief Valve

The thermal relief valve is mounted in the thermal relief line over the shut-off valve. The valve opens at a differential pressure of 1.5 psi.

10.6 Crossfeed Bleed Valve

For bleeding purposes a bleed valve is installed on the rear RH wing-to-fuselage fillet. The bleed line, routed from the highest point of the crossfeed line, is connected to the valve. The valve consists of a housing and a plug. For bleeding the plug must be unscrewed a couple of turns.

10.7 Check Valve

The check valve, mounted downstream of the water/methanol pump, prevents a reverse flow to the tank when crossfeeding and a small hole is drilled in the valve for thermal relief purposes.

10.8 Control

Two ON/OFF switches, one for each system, are provided on the RH overhead panel. When a switch is placed in the ON position, the water/methanol selector relay is energized, which closes the pump circuit. In case of propeller feathering, the appropriate propeller isolating relay is energized to close the shut-off valve and to interrupt the pressure indication circuit. Since the appropriate water/methanol selector relay remains energized, the operating engine will then be fed by both pumps as long as both tanks contain water/methanol. When one tank is empty the other pump will continue to supply the live engine. A pressure switch, connected to the outlet adaptor of the filter, will illuminate a green light on the RH overhead panel, when the water/methanol pressure has reached 12 psi.

END

40.0 QUANTITY INDICATING SYSTEM

The quantity indicating system consists of a dual indicator and two direct-lift tank units.
The indicator is normally installed on the RH overhead panel or on the main instrument panel.
The system is powered by 28 V DC.
There is also a quantity read-out on the fuelling control panel in the RH nacelle cone.

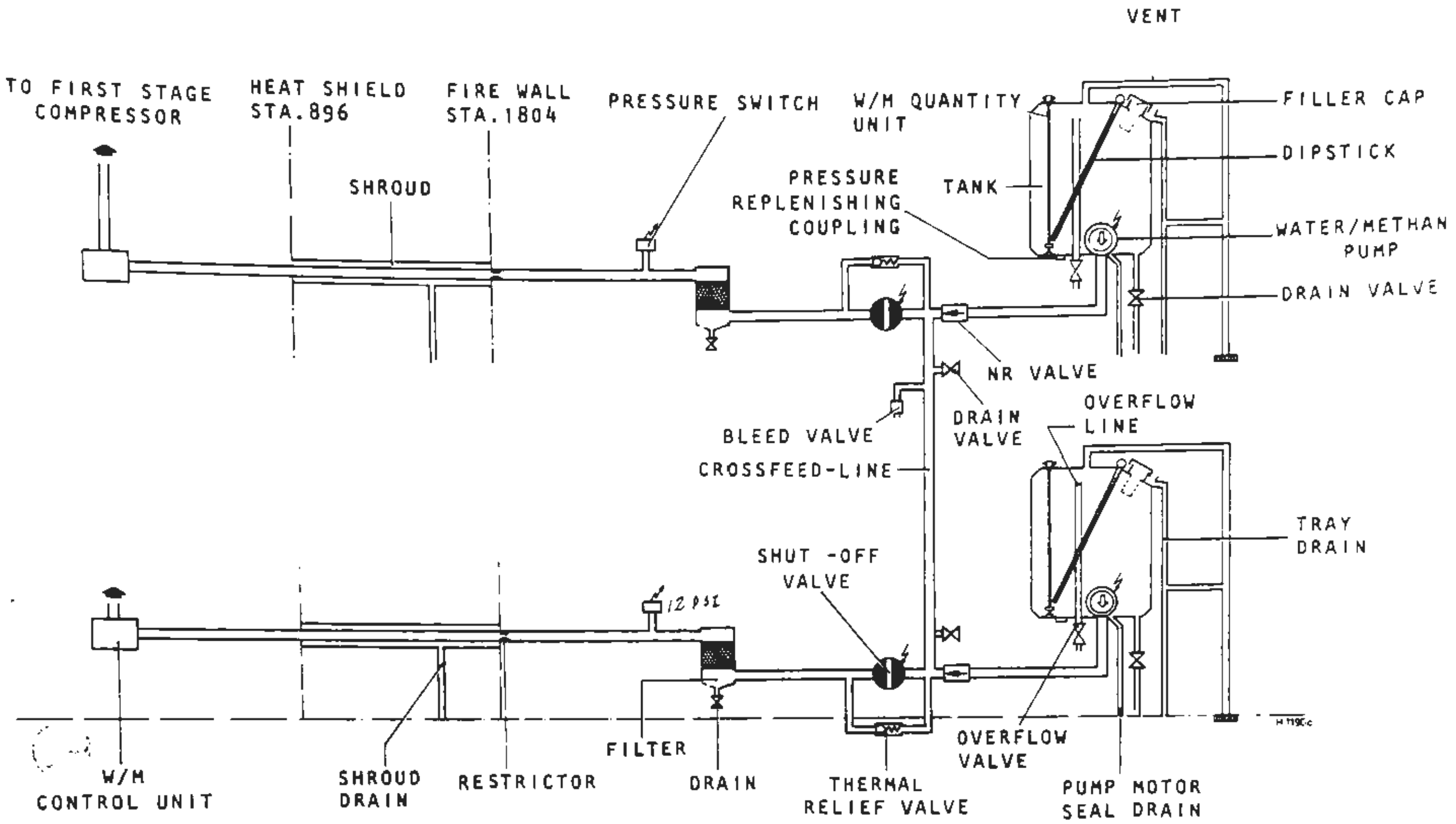
40.1 Tank Unit

The tank unit is a variable reed switch type resistor and consists of a fixed resistance with very close to it a strip with flexible fingers. A magnet, in a float, pulls the fingers in contact with the fixed resistance in this way varying the resistance when the float is moved.

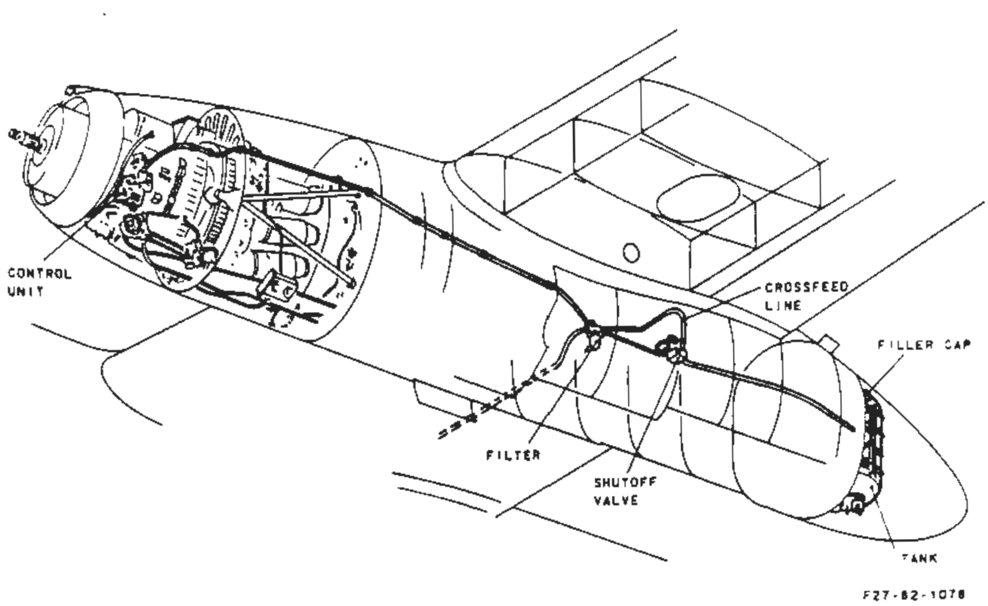
40.2 Indicator

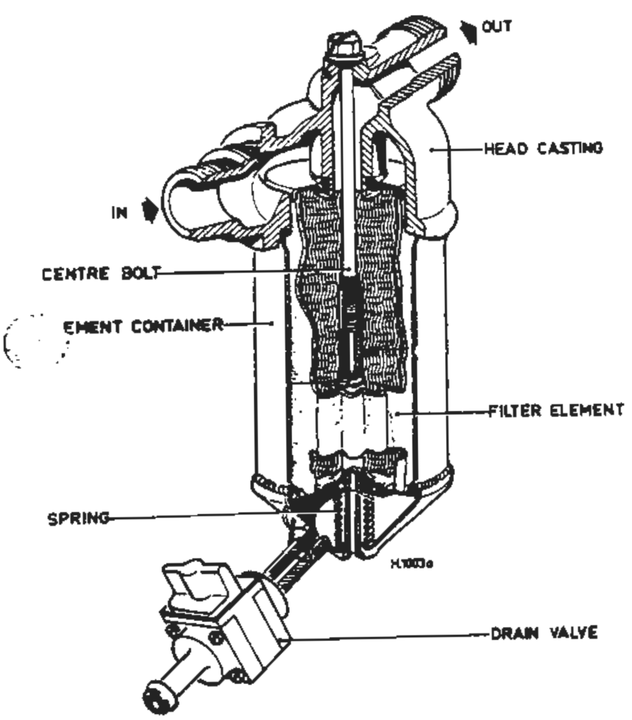
The indicator consists of two identical systems. Each system comprises a rotor with a permanent magnet to which a pointer is mounted and two stator coils connected to the tank unit. Variation in quantity will therefore vary the current and change the position of the indicator pointer.

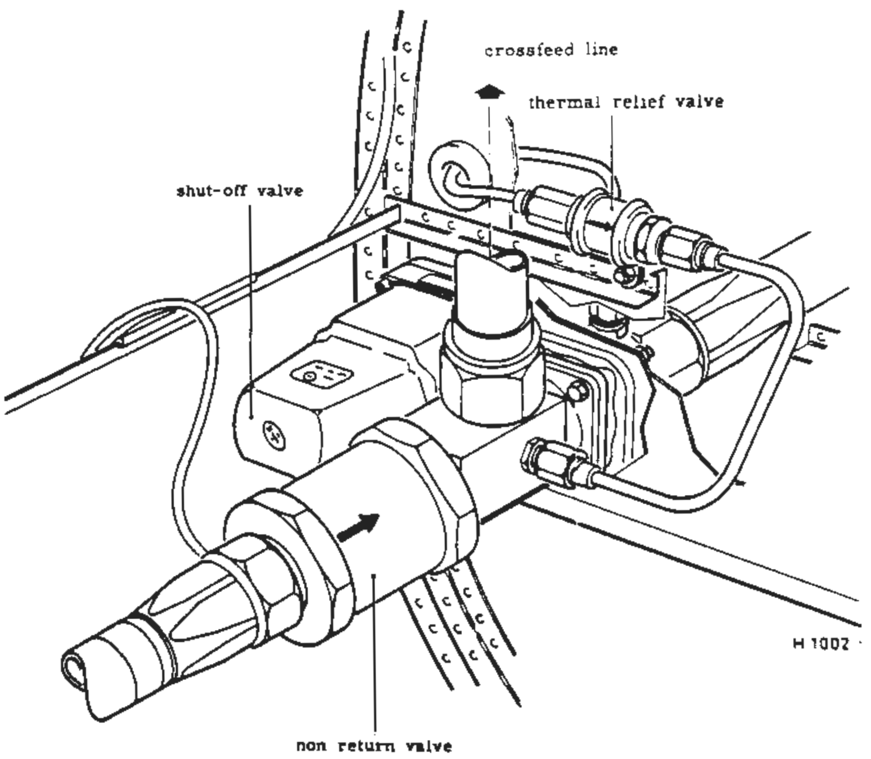
END



WATER/METHANOL SYSTEM DIAGRAM



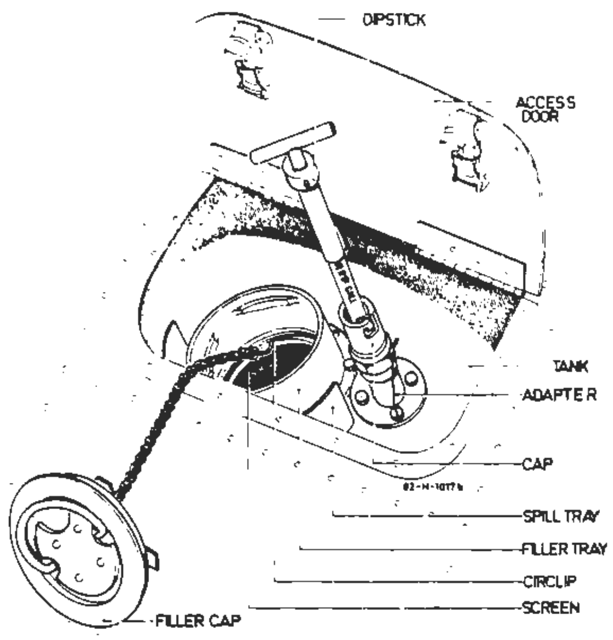




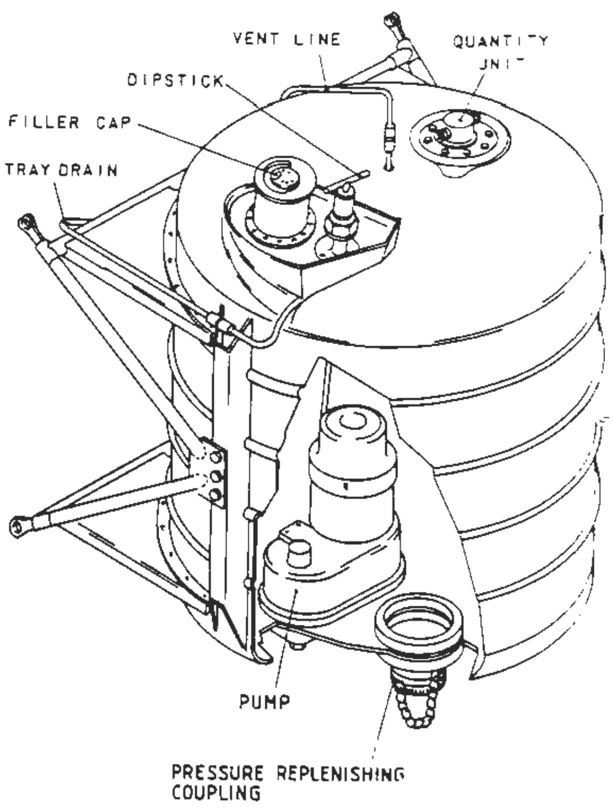
W/M FILTER

WATER/METHANOL SHUT-OFF VALVE

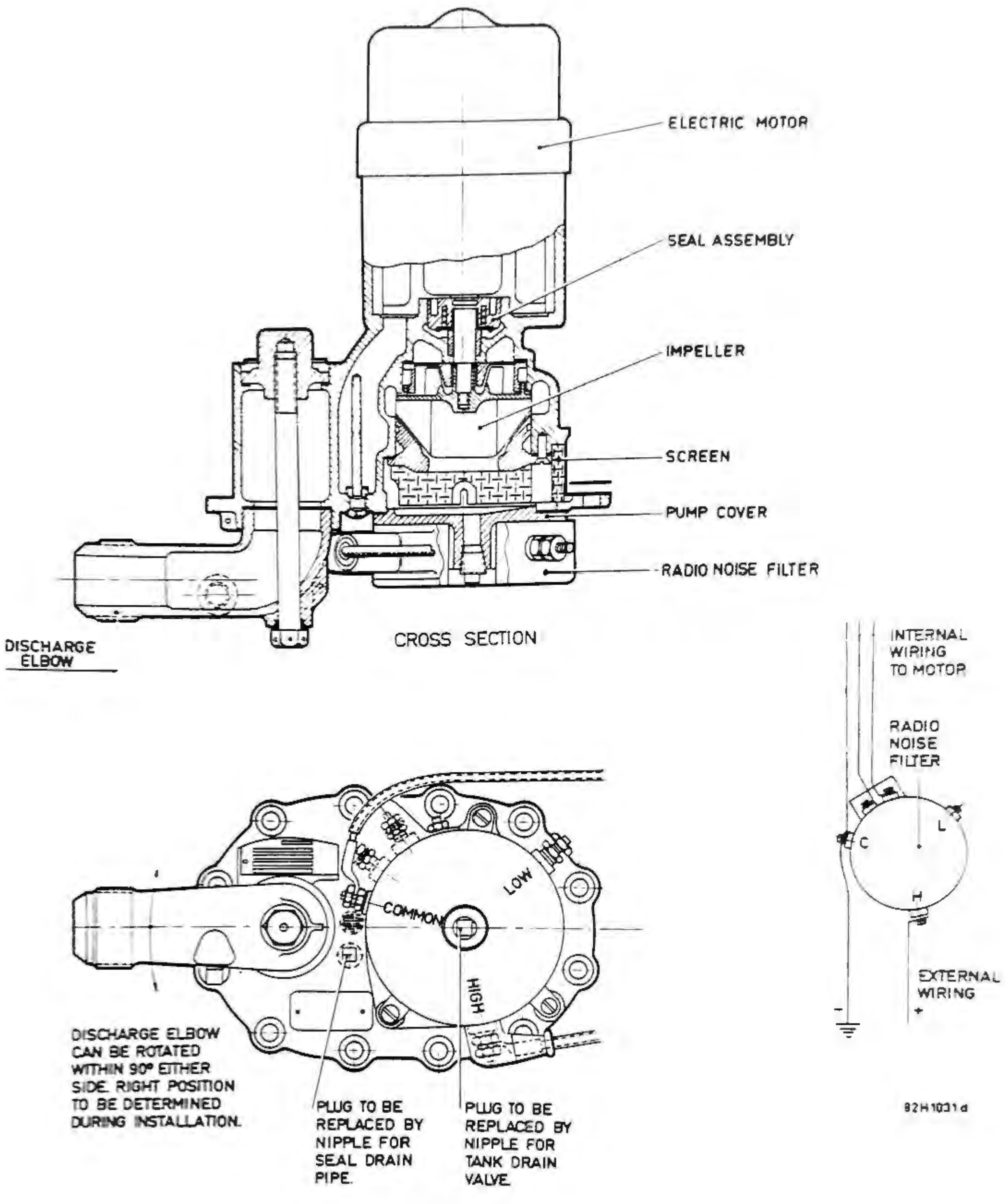
WATER/METHANOL SYSTEM - COMPONENTS



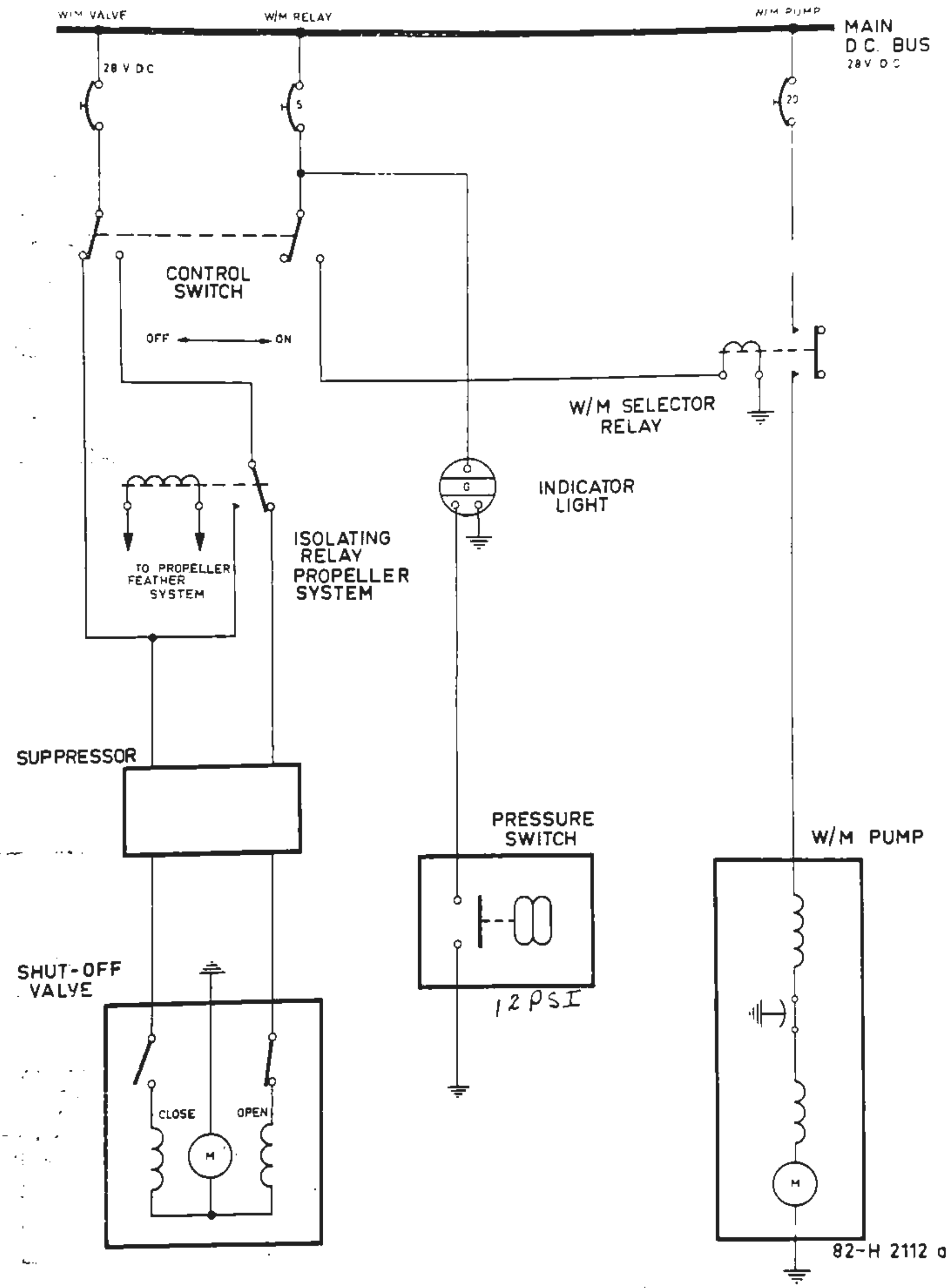
NOTE: THE TANK CAPACITY IS GIVEN IN LITERS IMP. GALLONS OR US GALLONS. THE DIPSTICK IS CALIBRATED ACCORDINGLY



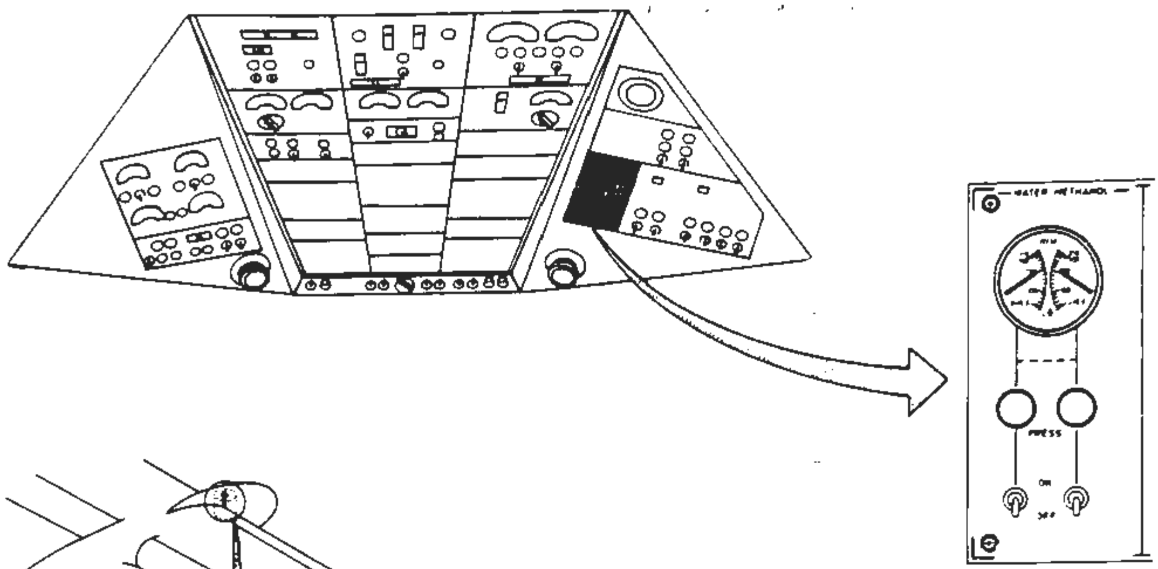
WATER/METHANOL TANK

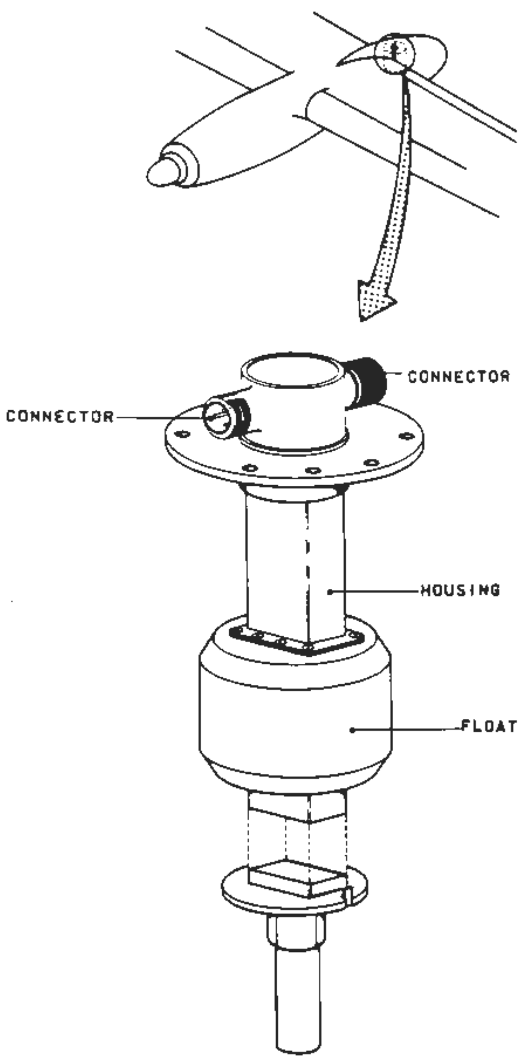


WATER/METHANOL PUMP



WATER/METHANOL SYSTEM





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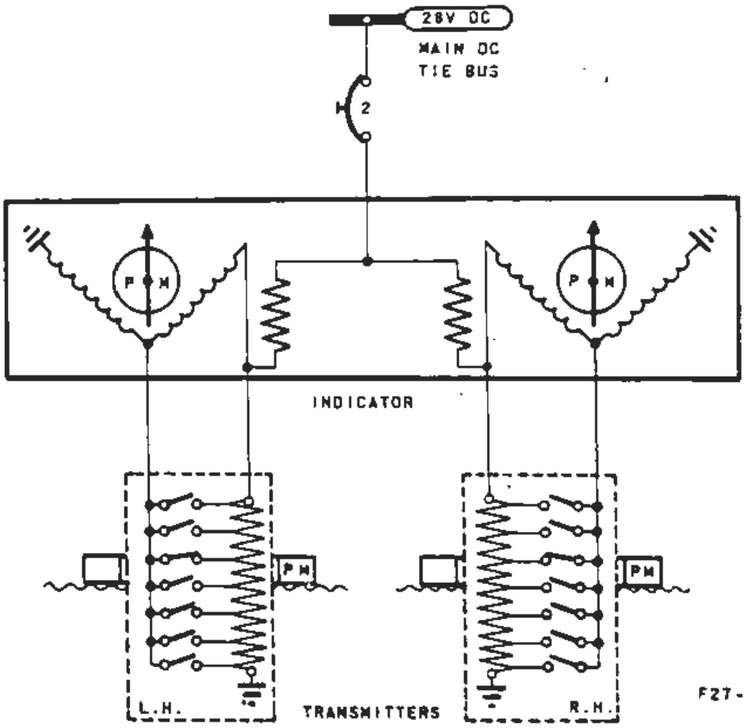

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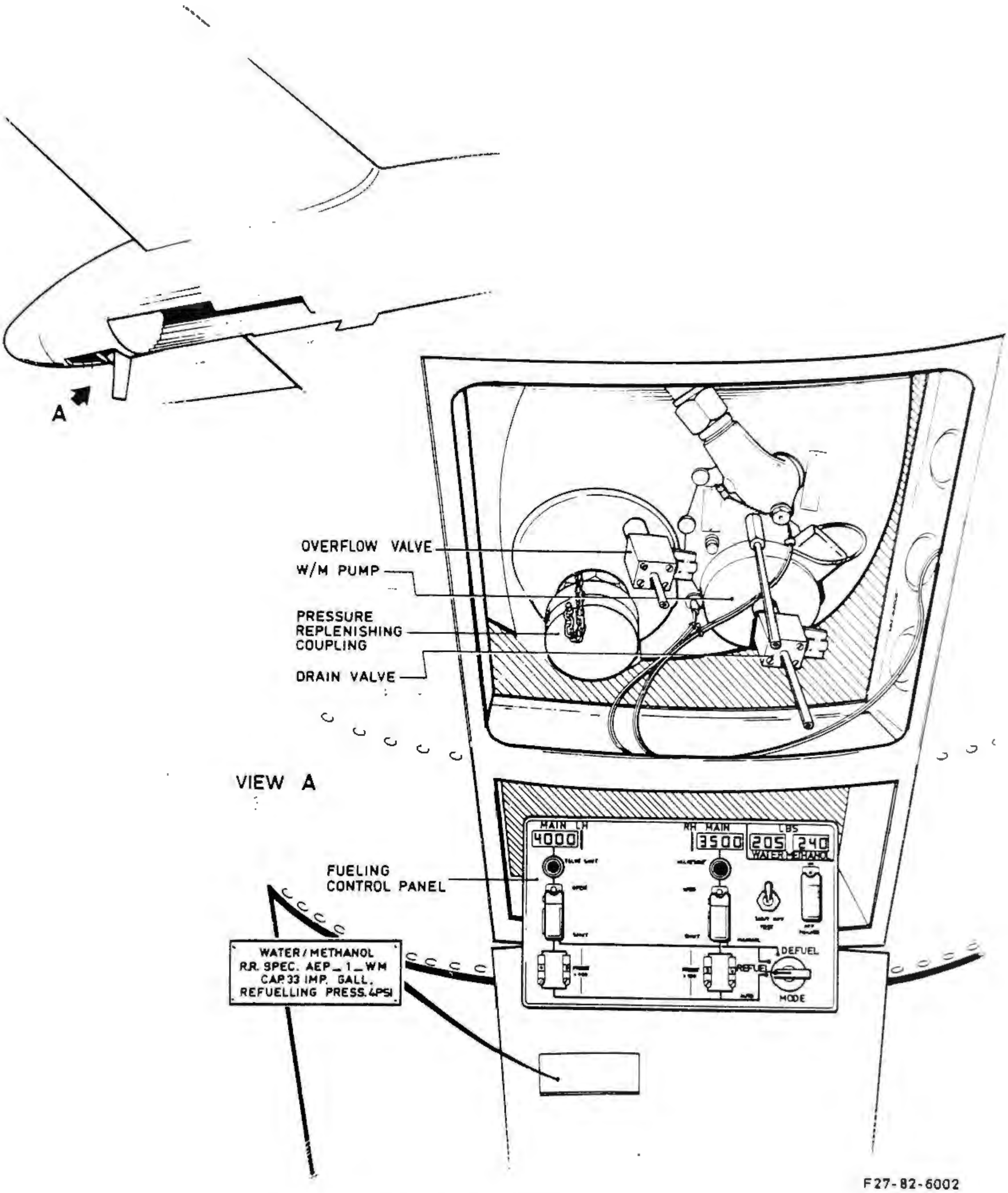
WATER/METHANOL SYSTEM QUANTITY INDICATION SYSTEM



WATER/METHANOL SYSTEM SERVICING

30 ICE AND RAIN PROTECTION

30. ICE AND RAIN PROTECTION

30. ICE AND RAIN PROTECTION

00.0 GENERAL

This chapter describes all systems employed in the F27 to keep the aircraft fully operational under adverse atmospheric conditions such as rain and ice.

Rain influences the view of the pilot through the windshields and therefore windshield wipers are installed.

Ice accretion on the aircraft during flight could be hazardous. The dangers of ice build-up are mainly; increased drag and decreased lift caused by alterations in the aerodynamic shape.
The most frequent form of ice is rime ice which occurs when super cooled water droplets strike the leading edges of wings and tail.

The surfaces on which ice accretion occurs and has to be removed are only the frontal areas which are exposed to the airstream, namely:

Leading edges of the wings, horizontal and vertical stabilizers
Engine air-intakes
Propellers and spinners
Pitot-static tubes
Windshields

De-icing and Anti-icing

There are two basic methods of countering ice problems on aircraft, known as "de-icing" and "anti-icing".
For the de-icing method the protection system is automatically switched on and off at regular intervals.
During the "off" period, a certain amount of ice deposit could accumulate on the particular surface, to an amount which would not seriously affect the aerodynamic shape.
The ice is then shed by operating the system for a short time.

In the anti-icing method the protection system is switched on prior to encountering icing conditions and it is left on so that no ice is formed on the surface.

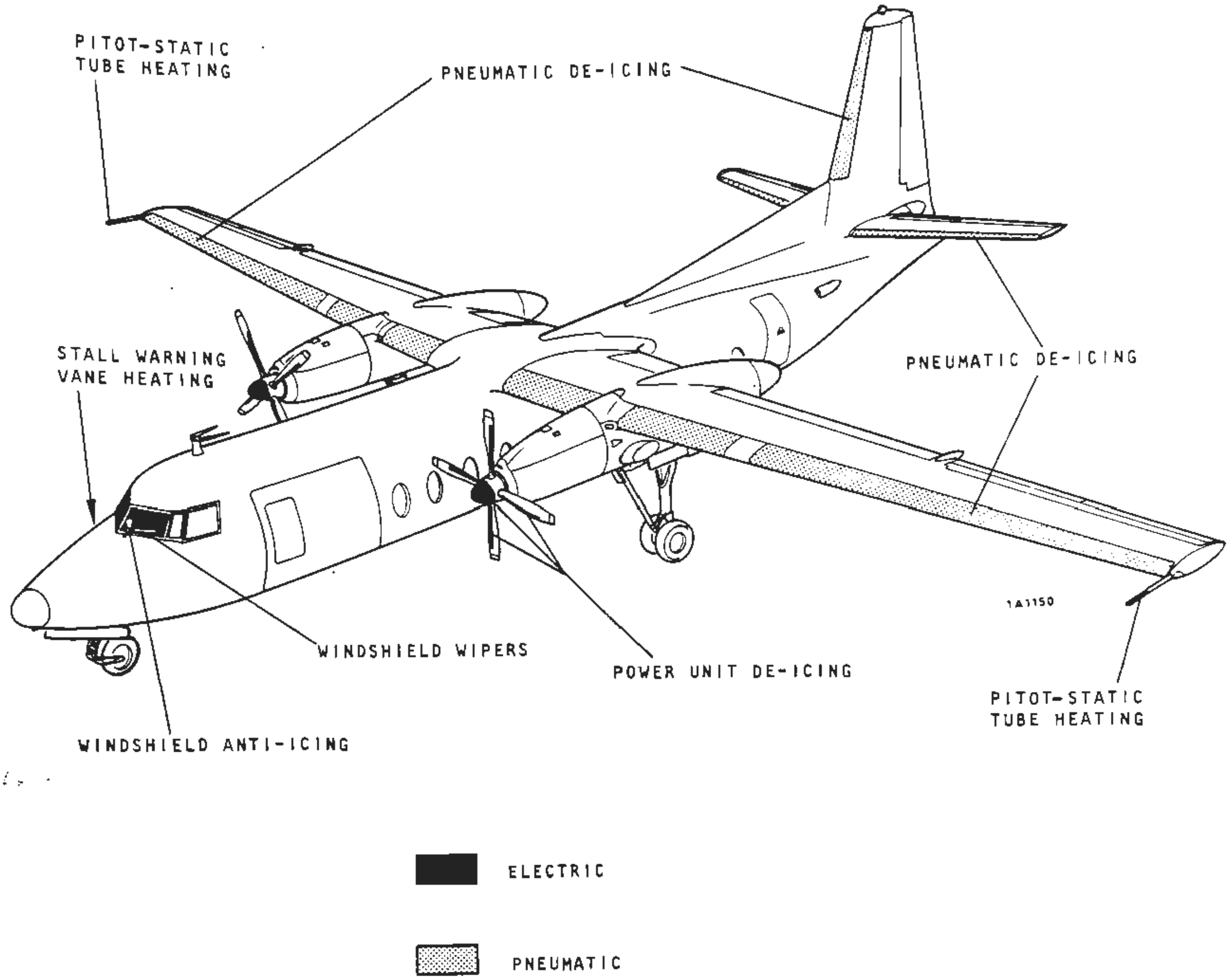
Types of Ice Protection System

Two principal methods of ice protection are in use on the F27:

1. A pneumatically-operated rubber boot installation for removal of ice from the leading edges of the centre and outerwings, and horizontal and vertical stabilizers.

2. An electrically-operated heater element system for removal of ice from engine air-intakes, propeller spinner and blades, windshields and pitot-static tubes.

END



DE-ICING AND ANTI-ICING

11.0 WING AND TAIL DE-ICING

General

De-icing of the leading edges of the wings, horizontal stabilizer and vertical stabilzer is done by a pneumatically-operated system. Rubber de-icer boots on the leading edges are inflated and deflated, whereby the ice layer is cracked and then removed by the airflow.
Air pressure to inflate the boots is obtained from the second stage of the compressor of each engine. The air pressure is applied to the boot sections by dual channel ejector distributor valves. To deflate the boots an underpressure suction is produced by venturies, located on the ejector distributor valves.

Description

On the leading edges there are 15 boot sections, each having two sets of channels (A and B). Pressure and suction for the boot sections is applied by 7 dual channel solenoid-operated ejector distributor valves, which are located on the wing front spar and in the tail section, adjacent their boot sections. Six dual-channel ejector distributor valves each control two boot sections, there is one valve that controls three boot sections.
An electronic timer located behind the LH overhead panel in the cockpit energizes the seven A-solenoids and the seven B-solenoids of the valves during a certain time and in a special sequence.
The solenoids can also be energized by operating a switch in the cockpit.
When a solenoid is energized, its associated boot channels inflate, when the solenoid de-energizes, the boot channels deflate.

The compressor of each engine supplies air via a pressure line to a de-icing panel in the engine nacelle. Here the air passes through a check valve, a water separator and filter, and a pressure regulating and relief valve. The latter valve limits the air pressure at 18 psi. In case the pressure exceeds 20 psi because of a failing pressure regulation, the relief valve relieves the air pressure (18 psi = 1.27 kg/cm2 = 124 kPa, 20 psi = I.41 kg/cm2 = 138 kPa).

System pressure is displayed on an indicator, located on the RH side panel in the cockpit. The system is operated by controls located on the WING AND TAIL DE-ICING panel on the LH overhead panel in the cockpit.

Operation

Ice can effectively be removed from the leading edges when it is allowed to build up to a minimum thickness of 6.5 mm. Therefore the de-icing system is used when there is a minimum ice layer on the leading edges. Ice accretion of more than 25 mm. should be avoided.
The de-icing system can operate in the automatic mode or the manual mode.
When the AUTO control switch is put in either LIGHT or HEAVY the electronic timer is switched on. The timer energizes the solenoids once per cycle. When LIGHT is selected a cycle takes 240 seconds, when HEAVY is selected a cycle takes 60 seconds. One cycle has 12 steps, 1 through 12.
The timer stays for 7 seconds in each step 1 through 8. The timer stays either 1 or 61 seconds in steps 9, 10 and 11 (HEAVY: 1 second, LIGHT:

61 seconds). The timer stays 1 second in step 12. When the timer is in any of the steps 1 through 8, 2 or 3 solenoids of the ejector distributor valves are energized and 2, 4 or 5 boot channels inflated. In steps 9 through 12 the solenoids are not energized.
When LIGHT or HEAVY has been selected the blue OPERATIVE light on the control panel is on. When the timer does not cycle the amber FAILURE light is on.
When the MANUAL control switch is pushed to "1" the A-solenoids of the valves energize and therefore all A boot channels inflate. When the MANUAL control switch is pushed to "2" all B-solenoids energize and the B boot channels inflate.

11.1 De-Icer Boot

The boots are made of neoprene rubber and are bonded to the honeycomb structure of the leading edge sections. The sections are bolted to the wings and stabilizers. Each boot section contains two separate air channels (A and B).
Except for the vertical stabilizer boot section, the inflation channels within all the boots run chordwise, i.e. they run parallel with the airstream, thus preventing interruption of the airflow when the system is in operation.
In the vertical stabilizer boot section, the inflation channels are arranged spanwise or at right angles to the airflow.

When one channel of a boot section is inflated, the other channel is connected to suction.

11.2 Timer

The timer operates when the AUTO control switch is in LIGHT or HEAVY. In the timer there is a motion detector, which detects whether the timer cycles. If the timer fails to cycle the amber FAILURE light comes on.
When the AUTO control switch is put to OFF the timer continues to cycle until it comes to step 12 accordingly the blue OPERATIVE light remains on until the timer stops at step 12.
Since the timer starts at step 12 and stays in step 12 for 1 second, the amber FAILURE light comes on for 1 second because the motion detector detects motion after 1 second.

11.3 Check Valve

In each air supply line from the engine compressor to the de-icing system, there is a check valve. The check valve prevents airflow from one compressor to the other. Thus allowing the de-icing system to operate in case of a single engine flight.

11.4 Water Seperator and Filter

The water separator removes moisture from the air coming from the engine compressor. The incoming air passes through a set of nozzles that causes it to swirl around in the separator can.
The moisture in the air condenses on the cool surfaces, and is collected in the bottom of the can. The water is drained overboard via a drain line.

The air passes through a filter element into the pressure regulating and relief valve.

11.5 Pressure Regulating and Relief Valve

The regulating part of the valve is operated by a power element, which consists of a spring and diaphragm. The relief part is controlled by a separate spring.

11.6 Pressure Gauge

The pressure gauge indicates the pressure in the air supply line to the ejector distributor valves. It consists of a sensitive Bourdon tube in a pressure-tight case. The tube is connected to the pressure line and the case to the static line (alternate static, see chapter ATA 34). The motion of the Bourdone is amplified and transferred to the pointer by means of a geared mechanism.
The dial is calibrated from 0 to 35 psi.

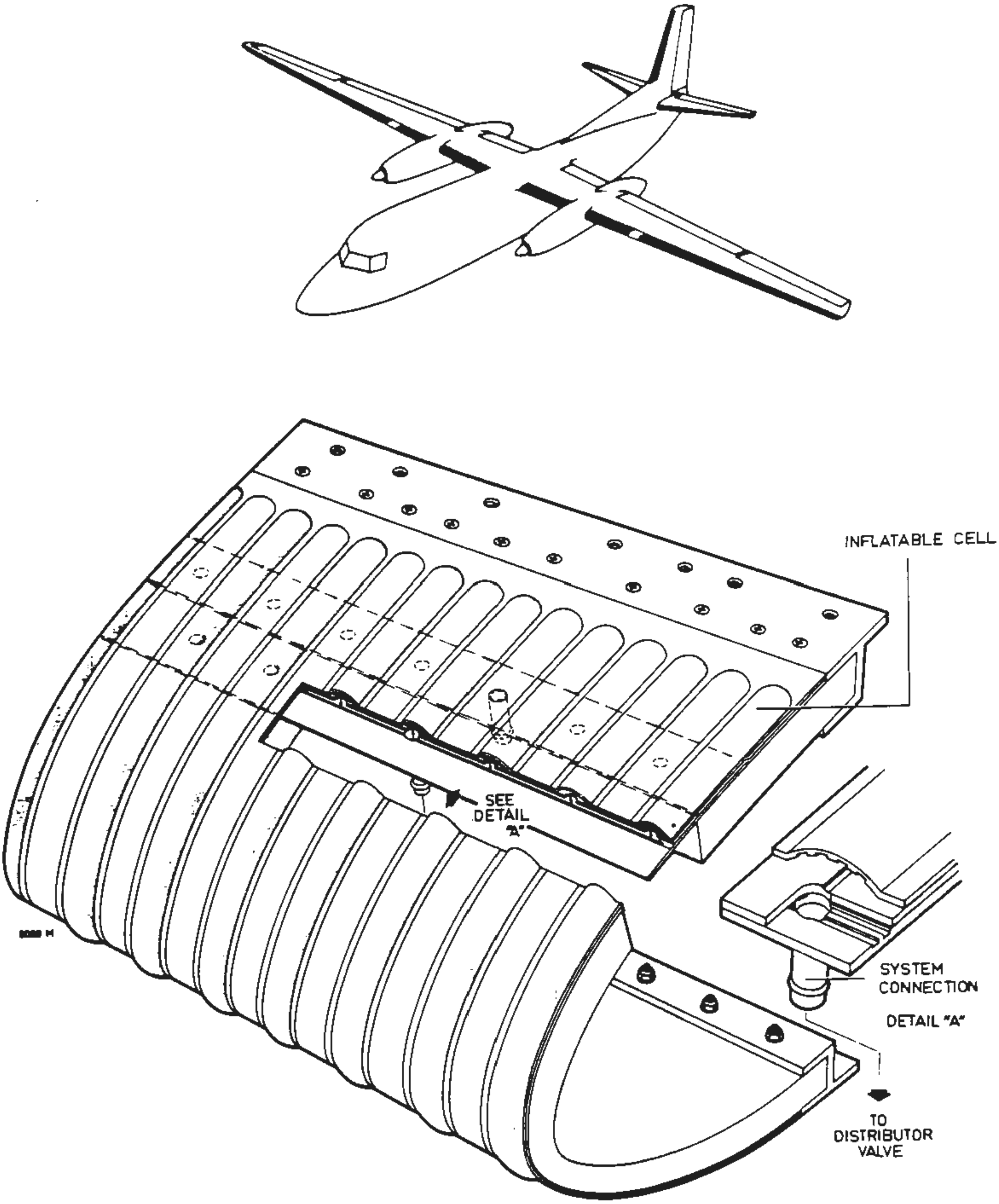
11.7 Ejector Distributor Valve

Each valve has two identical channels. When the channel solenoid is energized, a pilot valve moves, allowing air pressure to push the main valve off its seat. Air pressure can pass the main valve and is applied to the associated boot channels. When the solenoid is de-energized the pilot valve moves in the opposite direction. Air pressure on the lower side of the diaphragm causes the main valve to leave the valve seat. The boot channels start to deflate via the main valve and pilot valve. As long as there is overpressure in the main valve, a dump valve is pressed against the seat allowing the overpressure to be dumped quickly. A spring forces the dump valve against the valve seat when the pressure in the main valve decreases further. The pressure in the main valve and associated boot channels can further decrease due to the underpressure achieved from the air ejector/venturi.

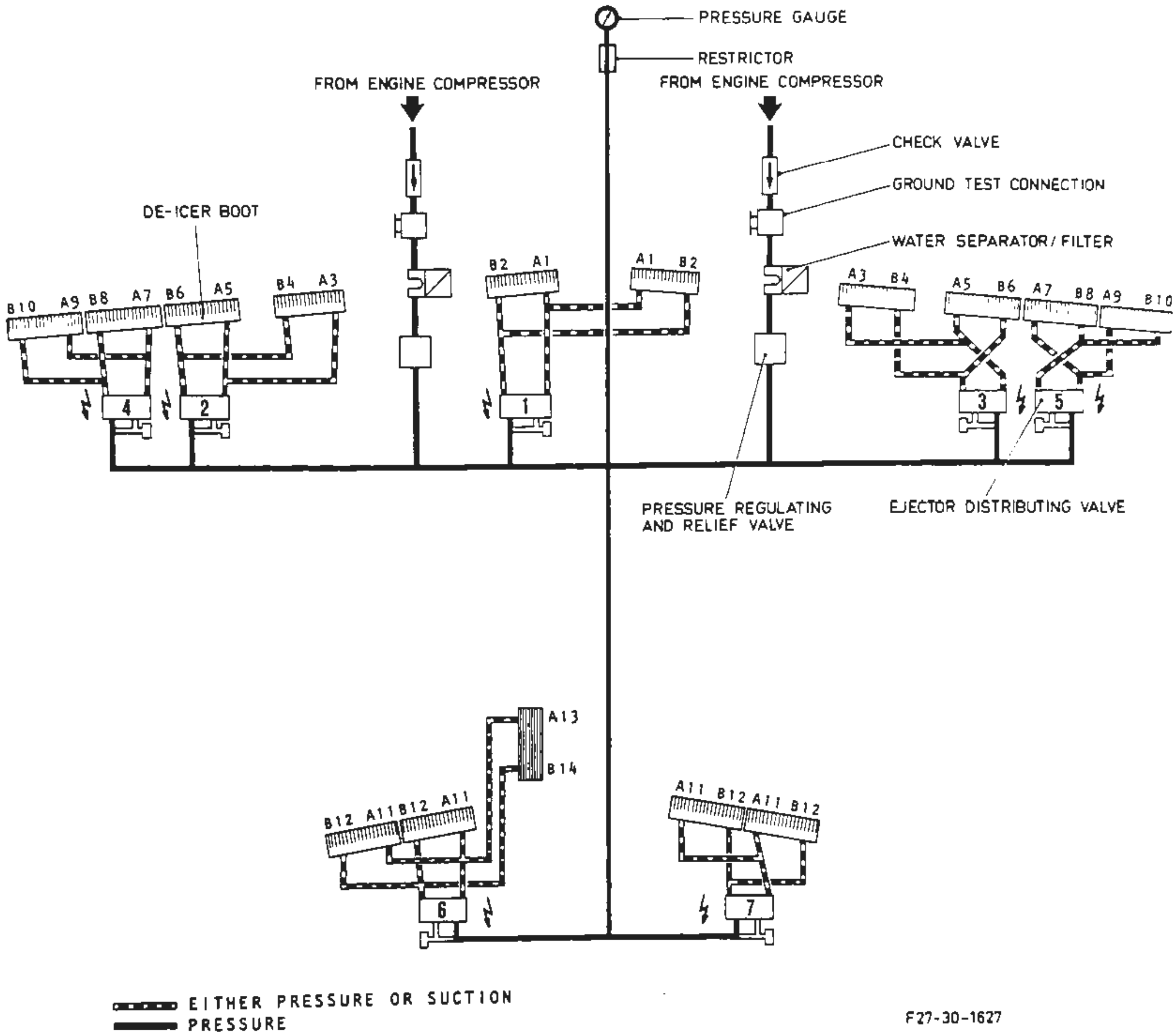
11.8 System Test

During the test switch on the system and verify that the boot sections inflate and deflate in sequence. Also verify that one cycle takes either 60 seconds (HEAVY) or 240 seconds (LIGHT).
Air to inflate, can be obtained from:
- the engines, running at cruise rpm or;
- a ground pressure source (1.5 lb/min. at 65 psi), which must be connected to the test connections downstream of each check valve.

END



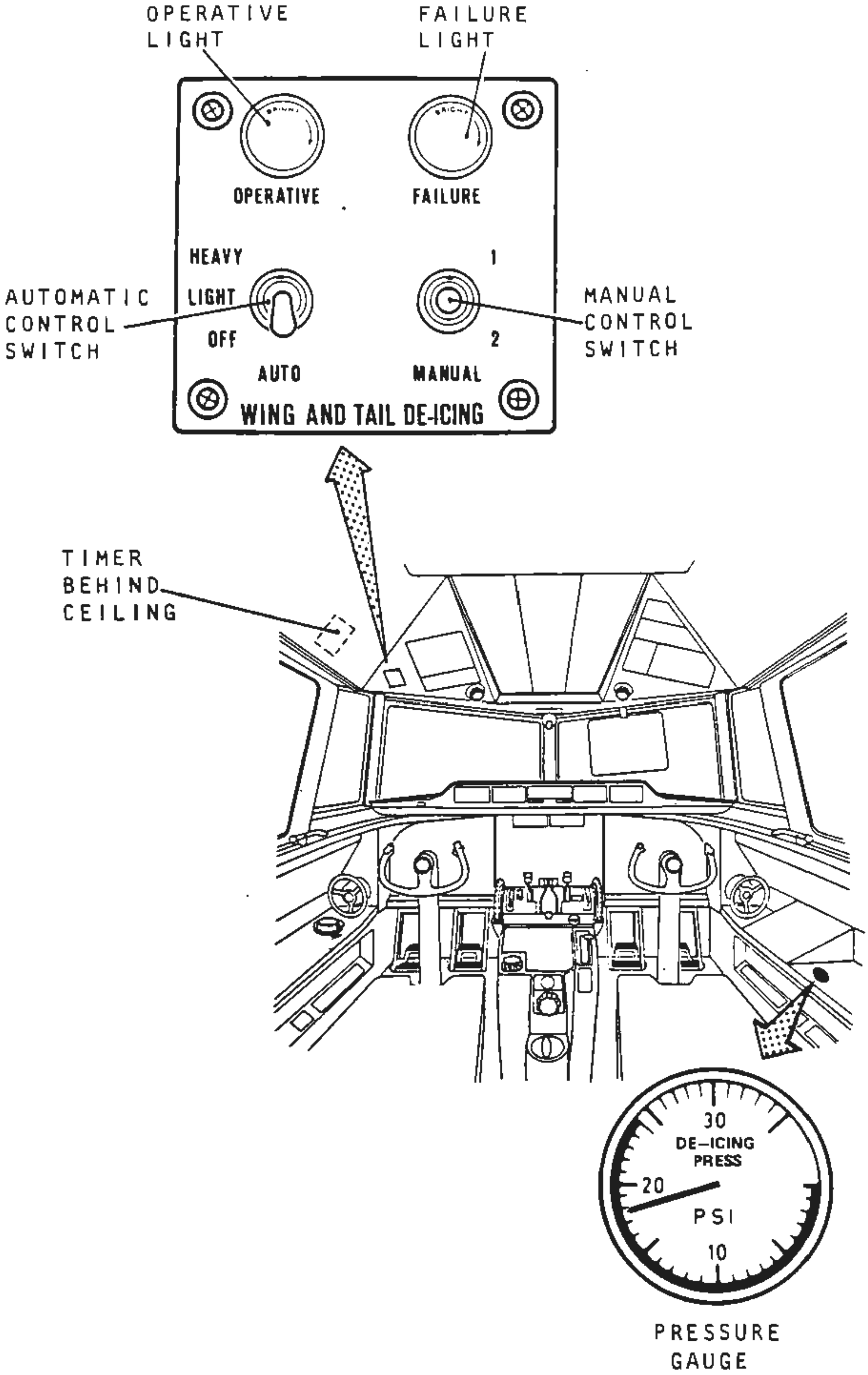
DE-ICER BOOT (CHORDWISE TYPE)



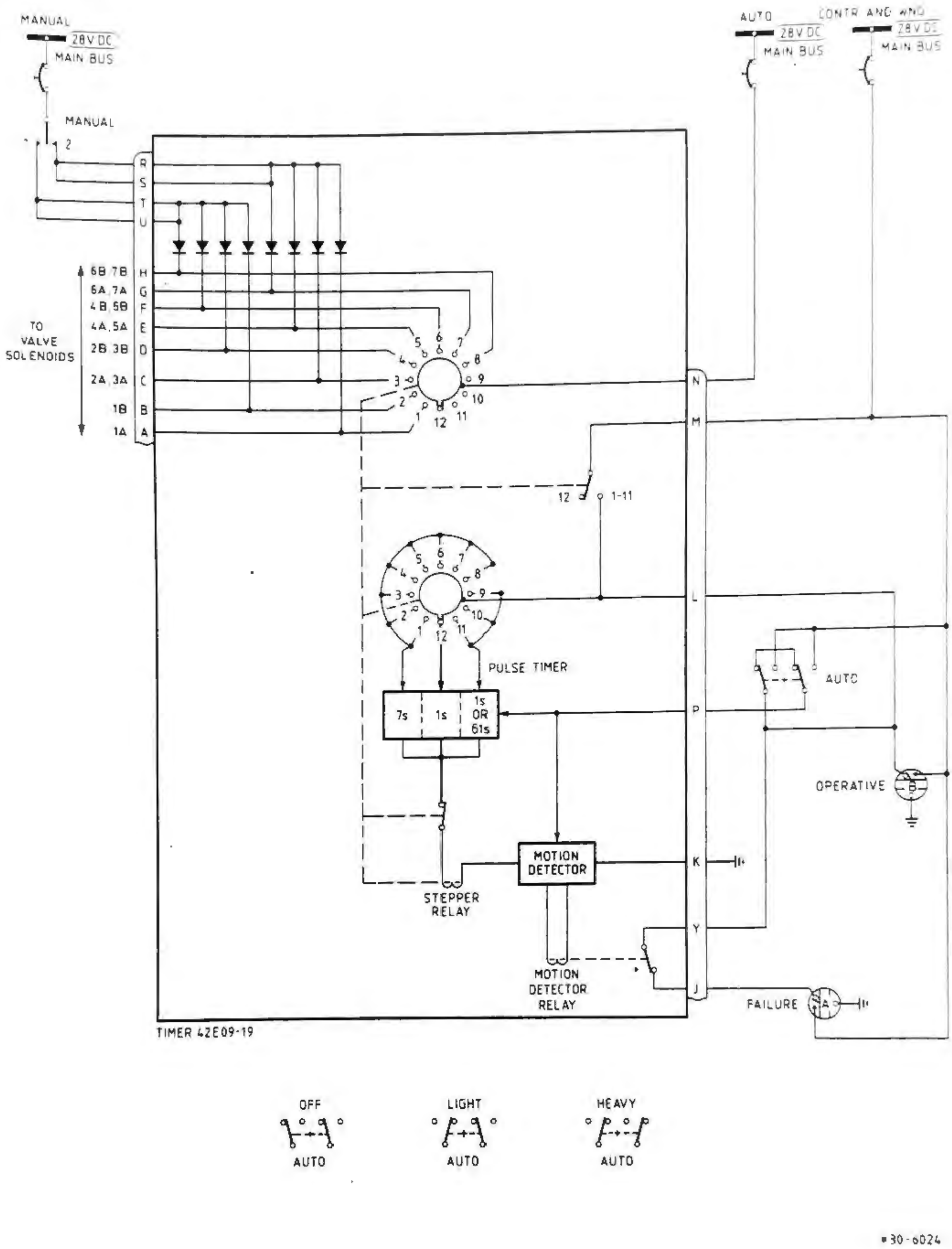
PNEUMATIC DE-ICING SYSTEM,DIAGRAM

STEP	TIME (s)	SOLENOID	INFLATED BOOT CHANNEL	AMOUNT OF INFLATED BOOT CHANNELS
1	7	1A	A1	2
2	7	1B	B2	2
3	7	2A, 3A	A3, A5	4
4	7	2B, 3B	B4, B6	4
5	7	4A, 5A	A7, A9	4
6	7	4B, 5B	B8, B10	4
7	7	6A, 7A	A11, A13	5
8	7	6B, 7B	B12, B14	5
9	1 or 61	—	—	—
10	1 or 61	—	—	—
11	1 or 61	—	—	—
12	1	—	—	—

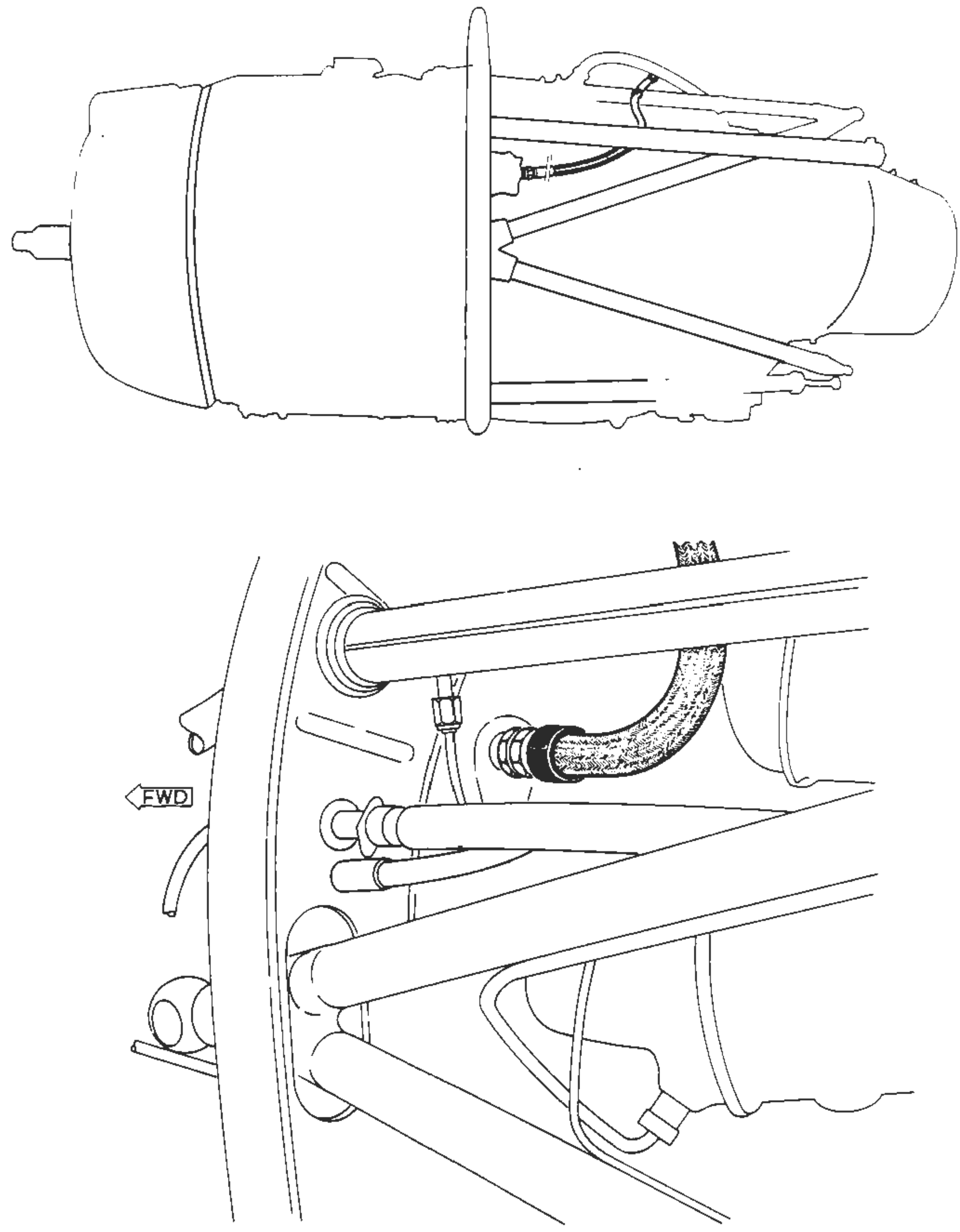
INFLATION SEQUENCE OF BOOT CHANNELS



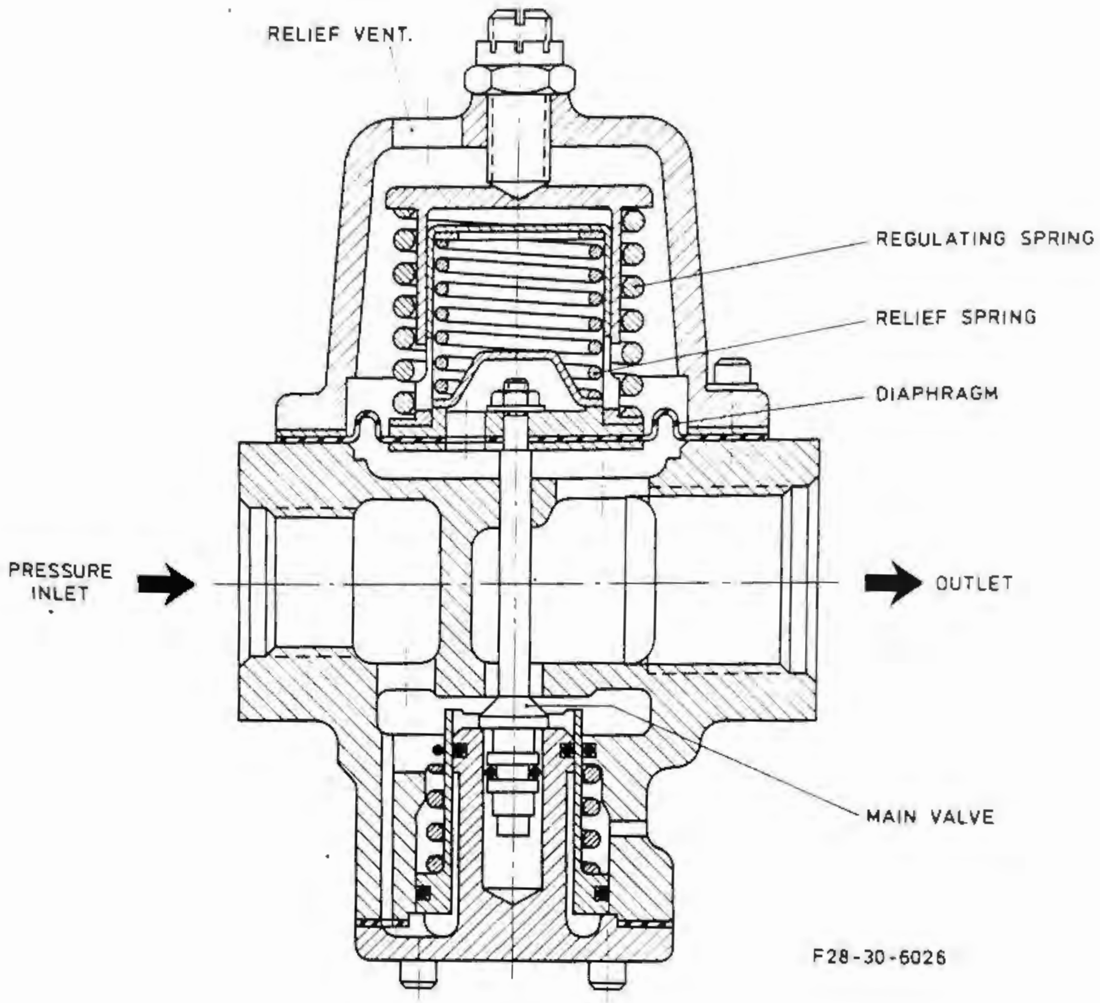
PNEUMATIC DE-ICING SYSTEM - CONTROLS AND INDICATION



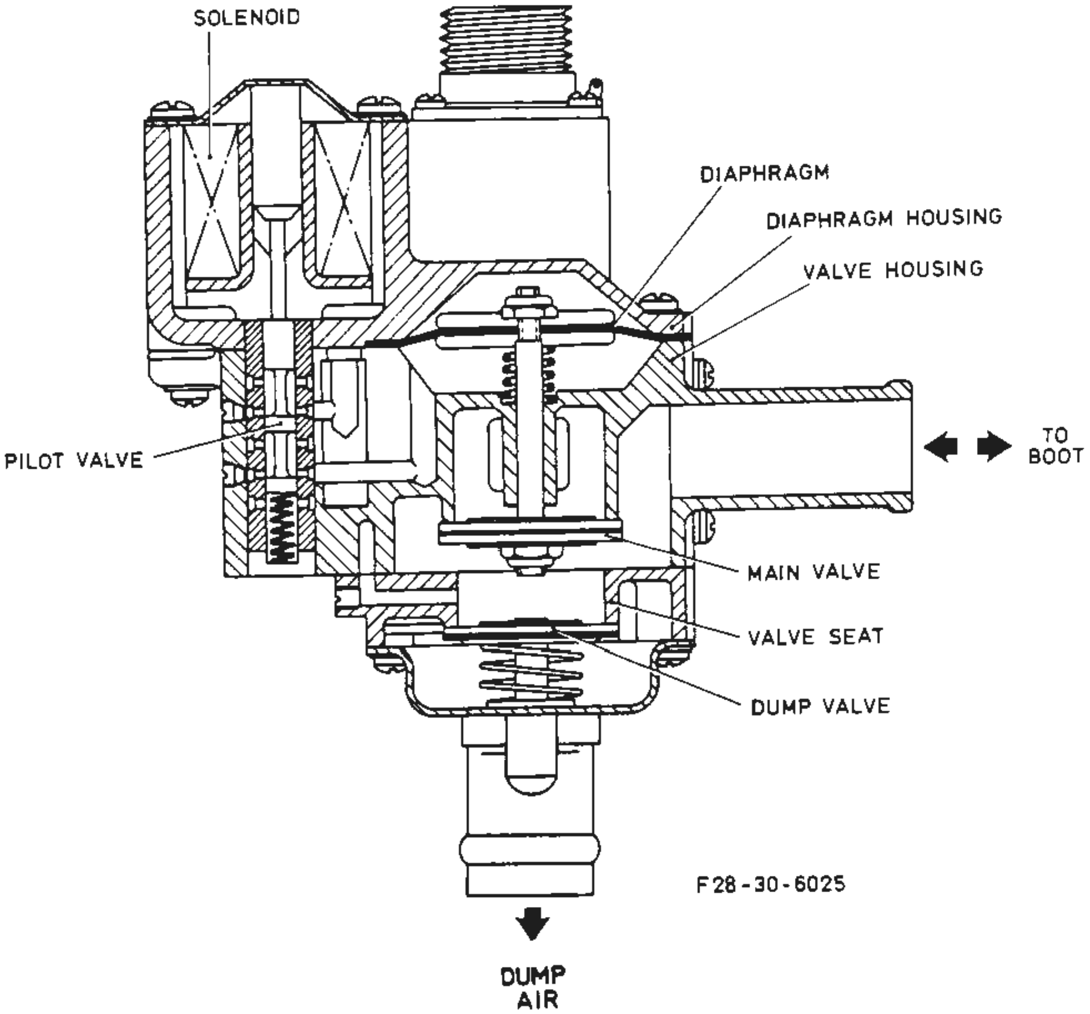
PNEUMATIC DE-ICING SYSTEM



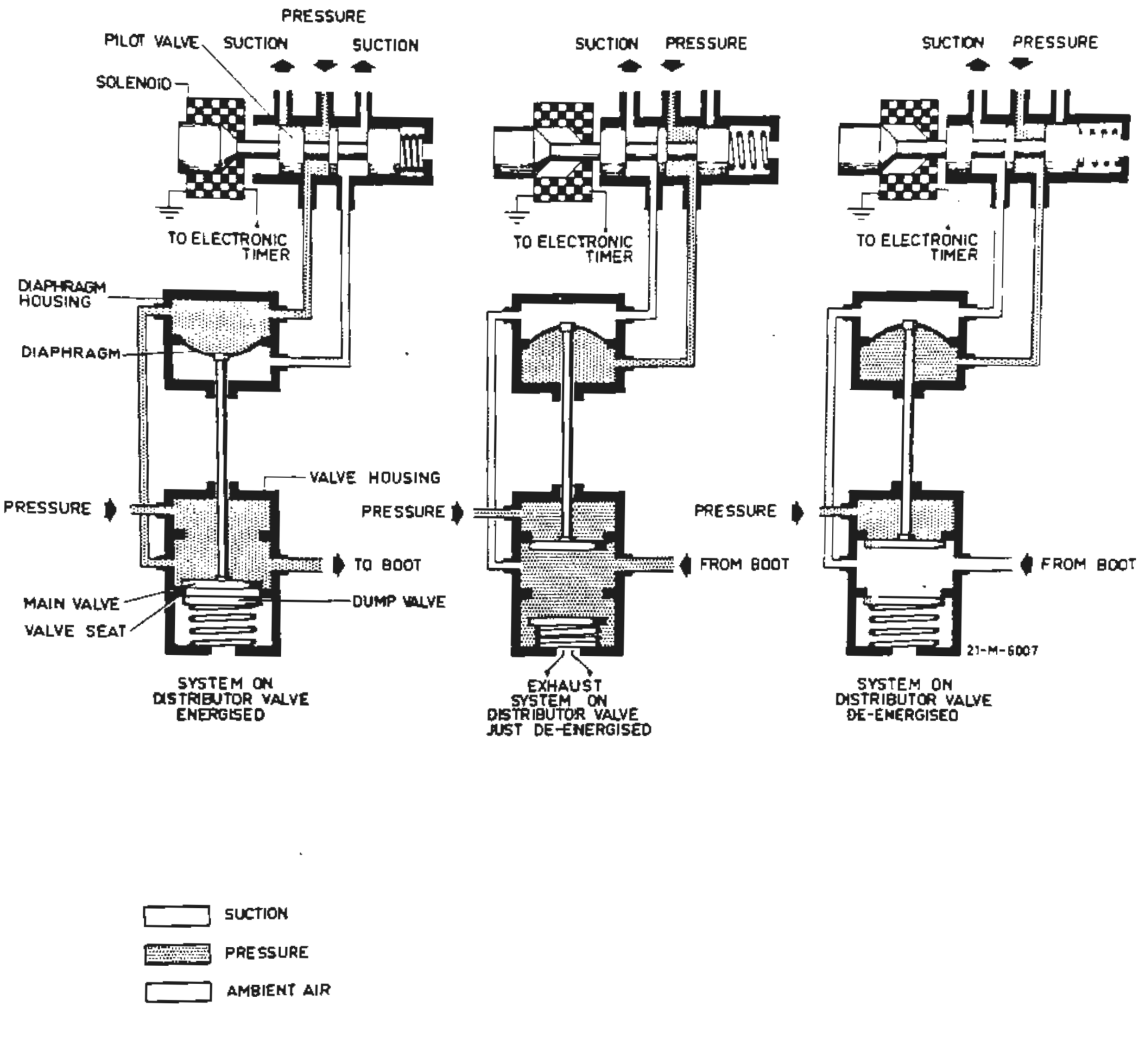
AIR SUPPLY



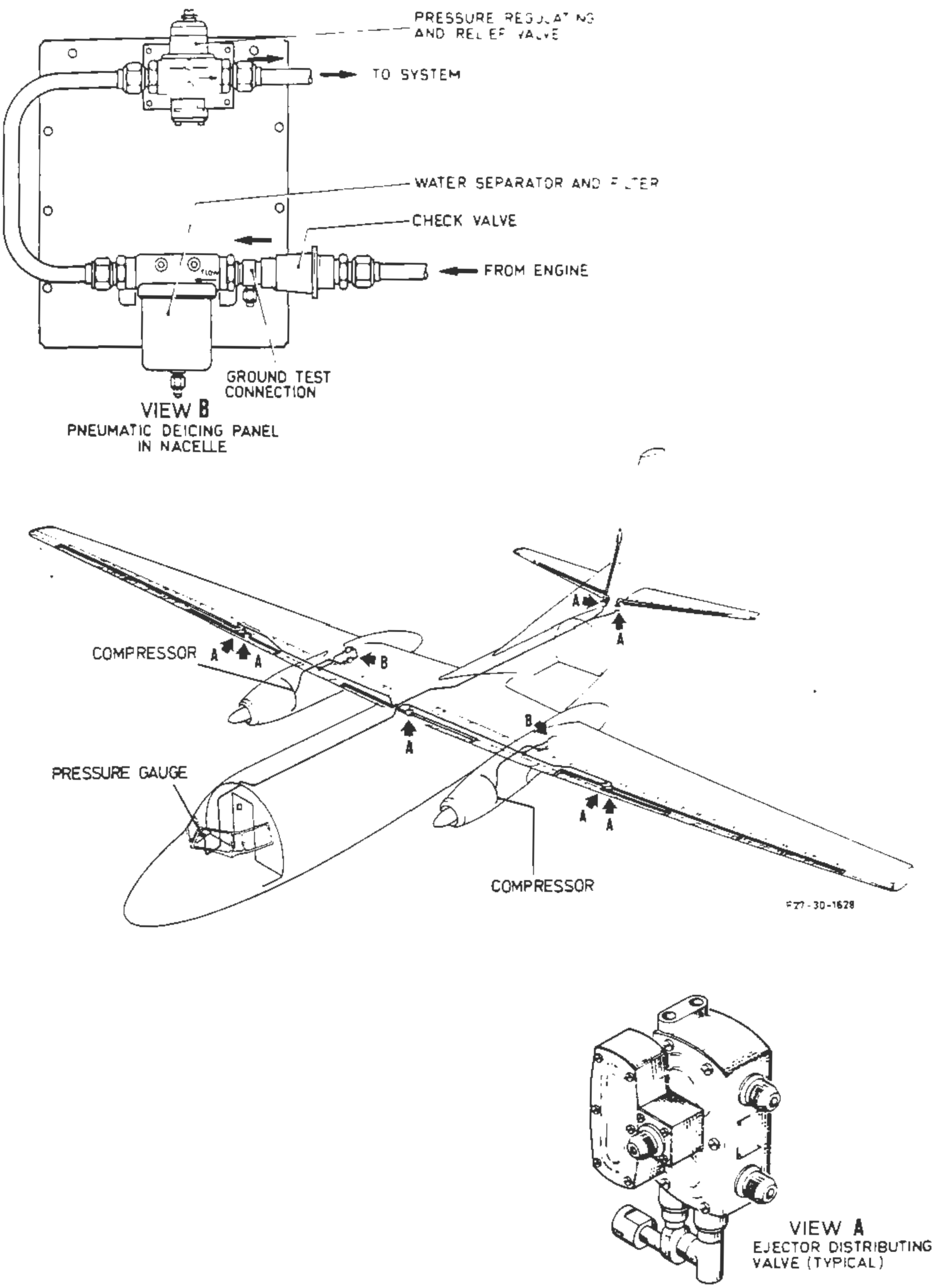
PRESSURE REGULATING AND RELIEF VALVE



EJECTOR DISTRIBUTOR VALVE



EJECTOR DISTRIBUTOR VALVE - PRINCIPLE OF OPERATION



PNEUMATIC DE-ICING SYSTEM - LOCATION OF COMPONENTS

30.0 PITOT-STATIC TUBE AND STALL WARNING VANE HEATING

Description

Two pitot-static tubes, one mounted on each wing tip, are provided with heating elements to prevent ice formation.

Each heating element is supplied from a 28 Volt bus via a circuit breaker, a relay and a control switch. The relay is located in the main junction box.

Both control switches are located on the LH overhead panel.
The LH pitot heater switch also controls the heating of the stall warning vane. Heating of the vane is impossible when the aircraft is on the ground.

In the switch line of each pitot-static tube heating element there is a current relay. Contacts of these relays interrupt the voltage for the amber lights, which are located just above the PITOT HEATING switches. When there is no current flow through the elements the amber lights are on.

NOTE: On the ground the PITOT HEATING switches must be in OFF to prevent overheating.

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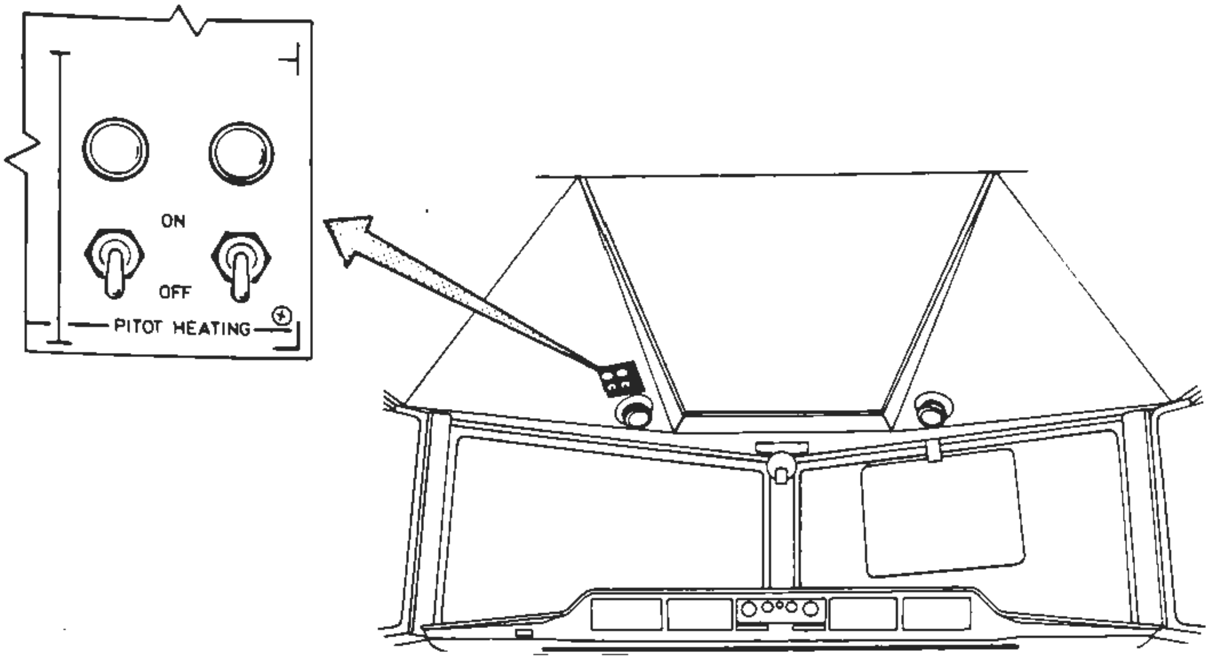
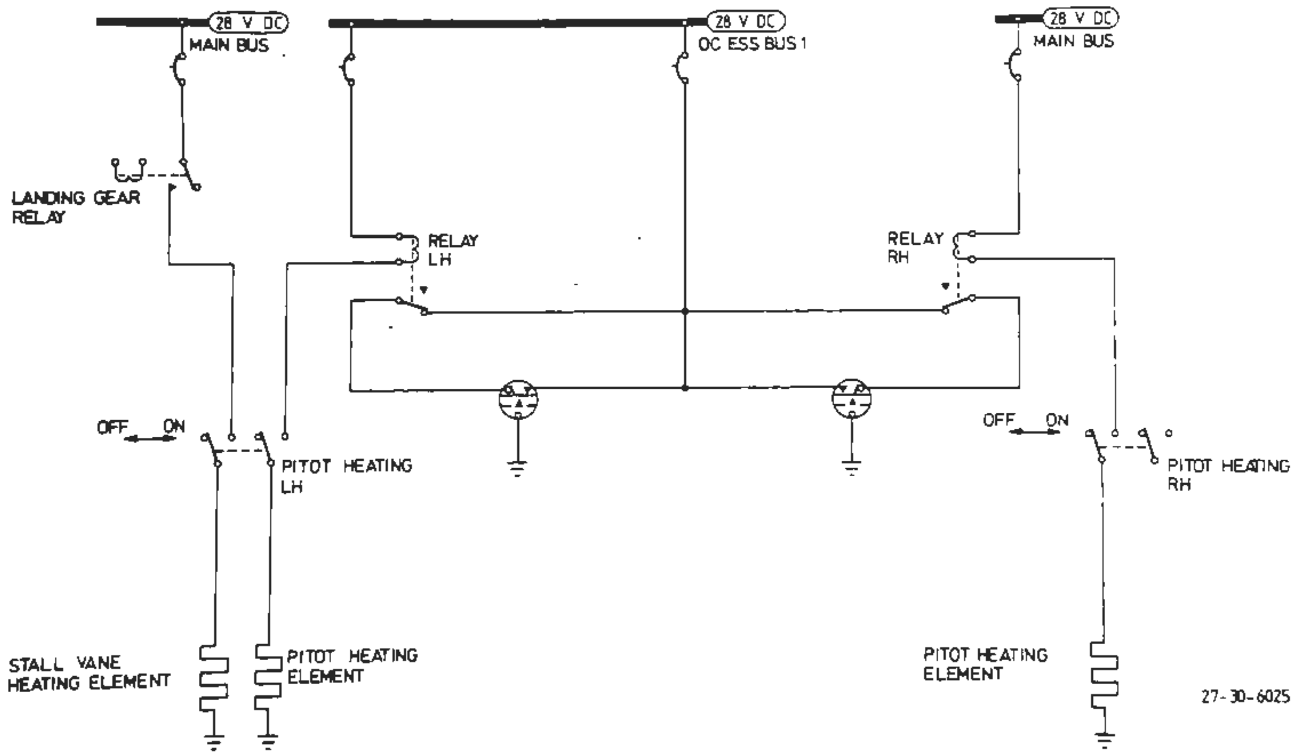




PITOT- STATIC TUBE AND STALL WARNING VANE HEATING

40.0 WINDSHIELD WIPERS

Description

An electrically operated windshield wiper system is provided for the pilot's and co-pilot's windshield.

The system has one electric motor, driving both wipers through flexible drive shafts and two converters.

The speed of the motor is controlled with a six position switch.

Operation

The six position selector switch is located just below the overhead panel. The switch has the positions PARK, OFF, START/FULL, $\frac{3}{4}$, $\frac{1}{2}$ and LOW. The switch is spring-loaded from the PARK to the OFF position.

To control the windshield wiper system, the selector switch must be set in an operating position.
The operating speed of the wipers is controlled by a resistor, except when the selector switch is in the "START AND FULL" position; then the motor is directly supplied with 28 Volts DC.

To stop operation, the selector switch must be turned through OFF to PARK, thereby depressing the spring-loaded selector switch which closes a microswitch circuit.
This causes the wipers to run at half speed to their park position, thereby closing the limit switch on the pilot's converter. On reaching the park position the limit switch closes and energizes a short circuit relay which connects the winding of the motor to earth thus stopping the motor.
Releasing the selector switch causes it to return to OFF and the system is ready for use again.

CAUTION: DO NOT OPERATE THE BLADES ON A DRY WINDSHIELD.

40. Resistor

A 160-Watt resistor, mounted in a perforated cage and installed on the cockpit right-hand side wall just under the motor, is inserted in the control circuit to vary the input voltage of the motor.
When the selector switch is in the FULL position, the circuit bypasses the resistor.
A 10-Amp automatic-reset circuit breaker in the restrictor assembly provides overload protection for the resistor during reduced speeds or in case the switch is held too long in PARK.

40.2 Motor

A variable speed, 28-Volts DC motor is located on the right-hand side panel at the rear of Sta. 1800.

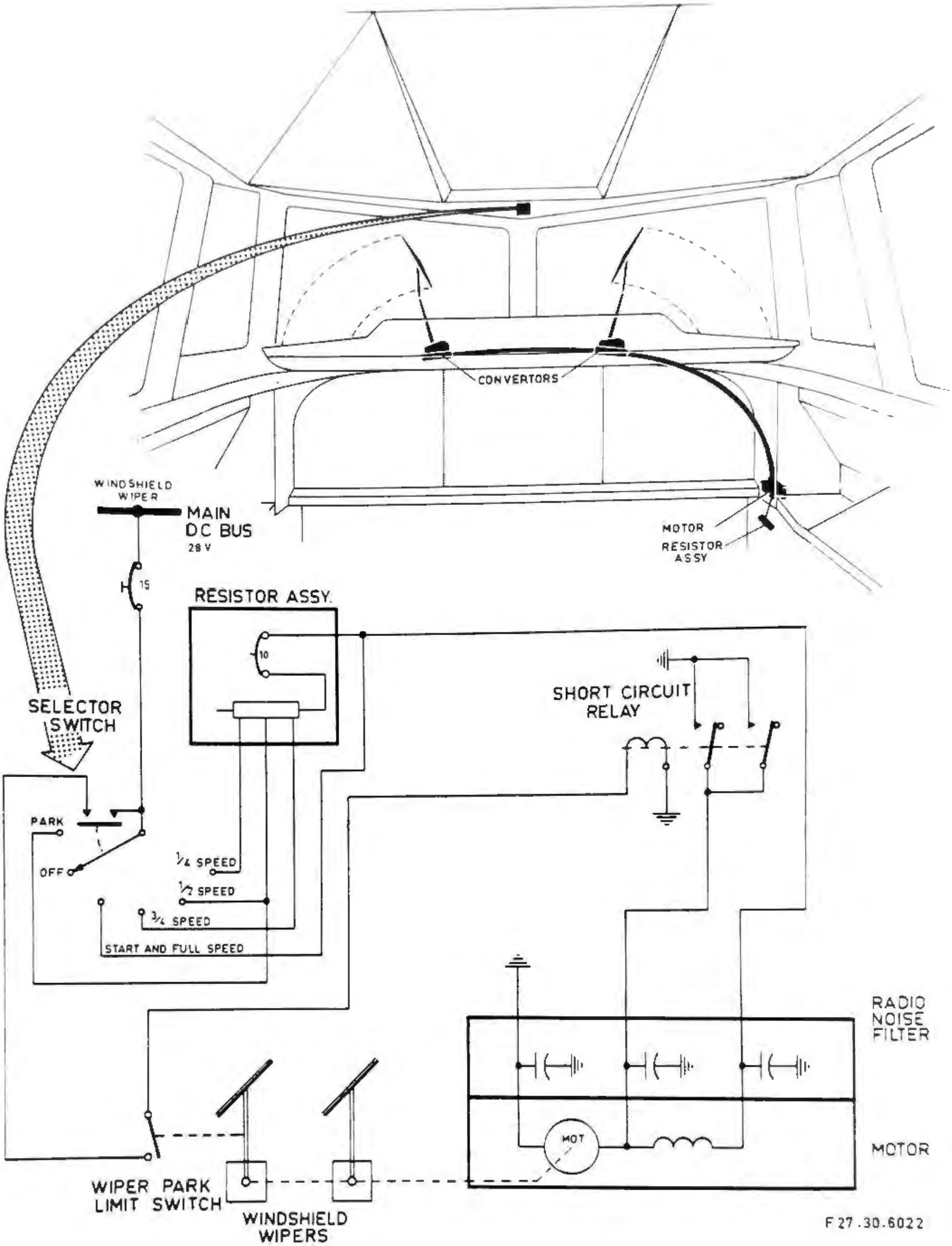
40.3 Flexible Drive Shafts

Flexible drive shafts are used to transmit torque from the motor to the right-hand converter and from the right-hand converter to the left-hand converter.

40.4 Converter

Two converters, one for each wiper, are attached to the aircraft structure directly behind each wiper and under the windshield panels.
By means of a worm and yoke gear system, the rotary motion of the motor is converted into an oscillating motion to drive the wiper arms.
The pilot's converter is equipped with a limit switch, which earths the motor winding when the wiper is in the PARK position.

END



WINDSHIELD WIPER SYSTEM

41.0 WINDSHIELD ANTI-ICING

Description

The pilot's and co-pilot's windshields are of the electrically heated laminated type, operating on the NESA principle as described in chapter STRUCTURE.

Apart from anti-icing, other advantages gained by electrical heating of a laminated glass/vinyl windshield are:

- Increase of impact resistance.
- The circuitry acts as a static discharge.
- Increased service life where low ambient temperatures are encountered.

A. Heating of each windshield is obtained by supplying AC power from their respective alternator buses, via a selector relay and a transformer to the transparant conductive film between the surfaces of the laminated glass windshield panel.

B. The temperature of the window is regulated by the temperature control box, which receives signals from the temperature sensing element in the window and which controls the selector relay.
This relay connects either a predetermined part of the transformer primary winding or the complete primary winding to the 208-Volt AC power supply depending upon the position of the selector switch, and accordingly the window will be heated.

Operation

When the ambient air temperature is + 18 degrees C or below, the heating must be switched on by positioning the selector switches on the LH overhead panel to LOW.

NOTE: The other position, HIGH, should only be selected after the switch has been in the LOW position for a period of three minutes. This is to prevent windshield panel damage due to too rapid heating.

After the system is switched on, 28 Volt DC energizes a control relay, which provides 115 Volt AC to the temperature control box and 28 Volt DC to the magnetic indicators, located on the LH overhead panel.

With the selector switch in HIGH the relevant solenoid of the selector relay is connected to ground.
On a signal from the temperature control box this solenoid is energized and connects 208 Volt AC to the transformer, thus heating the window with full power.

In the LOW position the selector switch connects the second solenoid of the selector relay to ground, causing the transformer to deliver a reduced voltage to the windshield panel.

41.1 Selector Switch

This is a three position switch located on the LH overhead panel.
It connects the system to the 28-Volt DC supply and to ground simultaneously and has the positions OFF, LOW and HIGH.

41.2 Selector Relay

The selector relay, situated on the de-icing relay panel in the cargo compartment is used to complete or to interrupt the power supply circuit of the transformer primary winding as dictated by the temperature control box.

41.3 Transformer

A transformer located on the de-icing relay panel supplies current to the windshield panel at two different voltages, dependent on the LOW or HIGH position of the selector switch.

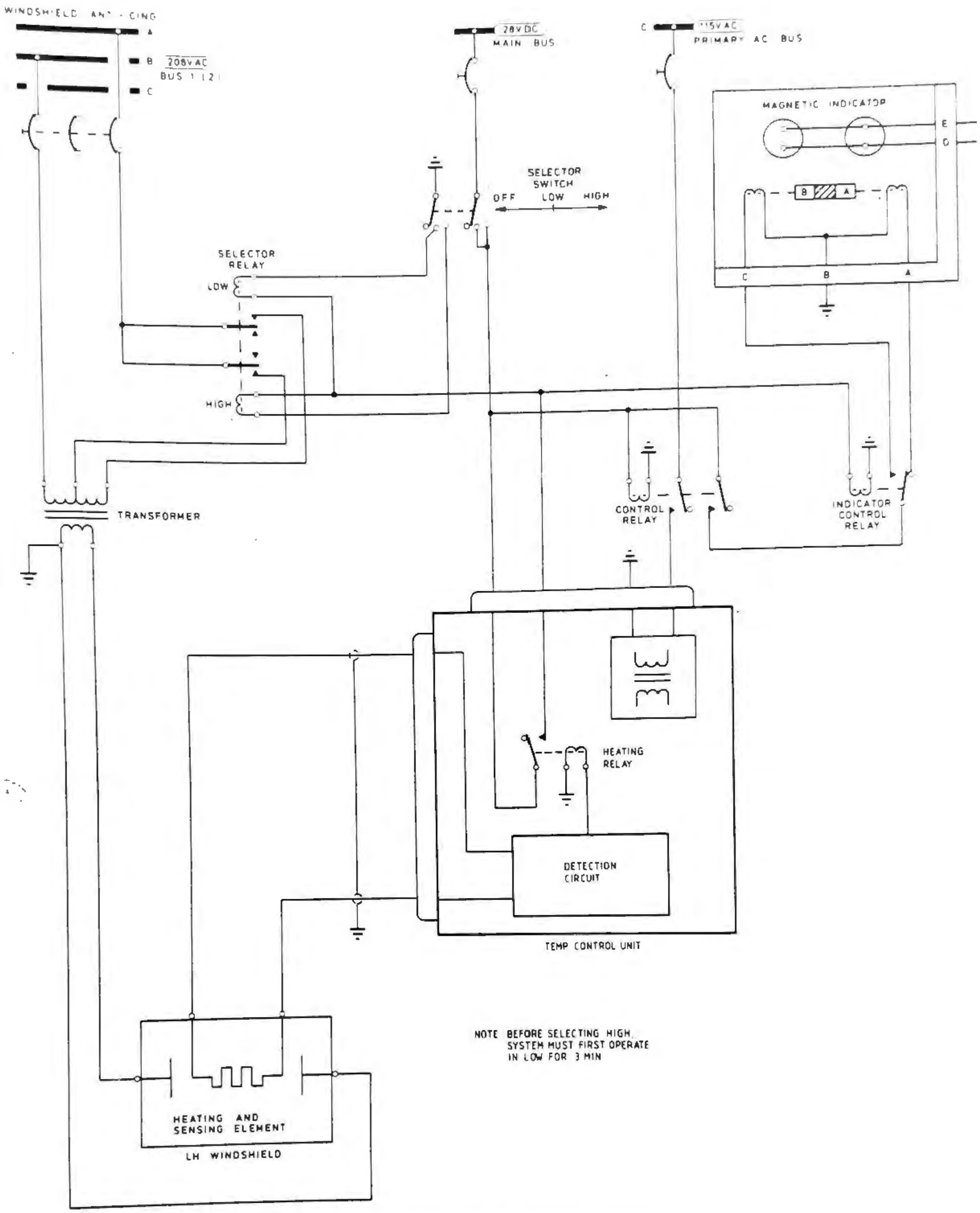
41.4 Windshield Panel

A windshield panel consists of two layers of tempered glass with a layer of shock-resistant vinyl plastic in between.
The inner surface of the outer layer is coated with conductive material applied sufficiently thin so as not to impair vision.
Current is applied to this coating by two contact strips, situated in the upper and lower edge.
A sensing element, embedded in the vinyl, is connected to the temperature control box for regulating the temperature of the windshield.
The temperature range over which the system is controlled is 32 degrees C to 54 degrees C (90 degrees F to 130 degrees F).

41.5 Temperature Control Box

The temperature control box situated on the cargo compartment ceiling is connected to the sensing element.
When the temperature in the windshield changes a relay in the box is either energized or de-energized.
This relay controls the 28-Volt DC supply to the appropriate selector relay solenoid.
The primary winding of the transformer then receives AC from the alternator system.

END



WINDSHIELD ANTI-ICING

60.0 AIR-INTAKE, PROPELLER AND SPINNER DE-ICING

Description

An electrical heating system is provided for the propeller blade leading edges, the spinner and the engine (power unit) air-intake.
Both systems are the same, therefore only one system will be described.

The heating elements are supplied by the alternator system. A part of the engine air-intake is continuously heated. The remaining part as well as the spinner and the propellerblade leading edges are heated cyclicly.
A cyclic speed switch automatically interrupts and completes the electrical circuit to the intermittently heated elements at a fast or slow cyclic speed.
The speed is controlled through a manually-operated speed switch, labelled FAST-SLOW.

The system is controlled by a three position switch, placarded ON-OFF-TEST.
In the ON position the switch closes a circuit to a power relay, which upon operation, connects the heater elements to the alternator system.
A current balance relay is fitted to interrupt the control circuit to the power relay if there is an imbalance of approximately 80 percent between any two phases of the alternator output.
Overload sensing elements interrupt the control circuit to the power relay, when the load exceeds 20 Amps in any phase.
An ammeter is fitted to check, via a selector switch (LOAD), either the total power consumption or the power used for power unit de-icing only.
A ground/flight relay and a ground safety relay are installed to prevent operation of the system when the aircraft is on the ground.

NOTE: Ground testing of the system is possible provided the switch is set to TEST and power lever setting is above 12,800 rpm to ensure a sufficient airstream for cooling of the heating elements.

Operation

A. Normal Control

In the ON position the switch completes the control circuit to the power relay via the current balance relay, overload sensing elements and the de-energized ground safety relay.
When the aircraft is on the ground the ground/flight relay is de-energized and operates the ground safety relay, which interrupts the control circuit to the power relay.
The speed switch, with the positions FAST and SLOW, controls the cycling speed of the cyclic speed switch. It should be selected:
FAST at outside air temperature between 10 degrees C and - 6 degrees C.
SLOW at outside air temperature below -6 degrees C.

B. Test Control

In the TEST position the power lever must be set beyond 12,800 rpm (throttle microswitch) to de-energize the ground safety relay.

NOTE: Holding the spring-loaded de-icing control switch in the TEST position is restricted to 4 minutes maximum (2 FAST cycles). DO NOT TEST AT SLOW CYCLING.

60.1 Overload Sensing Element

The overload sensing element is located on the de-icing relay panel in the cargo compartment, and protects the alternator from being overloaded.
The overload sensing element consists of a thermal disc for each phase.
When an overload in one of the three phases occurs, the circuit breaker in the DC supply line (AC OVERLOAD) will trip causing the power relay to break the heating current circuit to the heater elements.
When the overload sensing element has cooled down the circuit breaker in the DC supply line has to be reset to activate the power relay to complete the heating circuit to the heating elements again.

60.2 Current Balance Relay

A current balance relay, located on the de-icing relay panel, functions as a guard against an imbalanced phase load.
Tripping of a current balance relay takes place whenever an open circuit occurs on any of the three heating current supply phases, or whenver an imbalance between two phases in excess of 80% occurs.
Tripping of this relay causes the heating circuit to the heating elements to be interrupted as the power relay is de-energized and stays de-energized by means of a hold-in circuit.
The power relay can be re-energized by switching the control switch to OFF and ON again.

60.3 Cyclic Speed Switch

The cyclic speed switch is located on the de-icing relay panel. It controls the 3-phase AC supply to the air intake and propeller/spinner heating elements by energizing selector relays. The selector relays are energized via transistorized pulse-forming circuits which are triggered by a master pulser.
The master pulser also triggers a transistor which provides a negative for a blue indication light. The light will flash bright/dim alternately when the cyclic speed switch is operating.

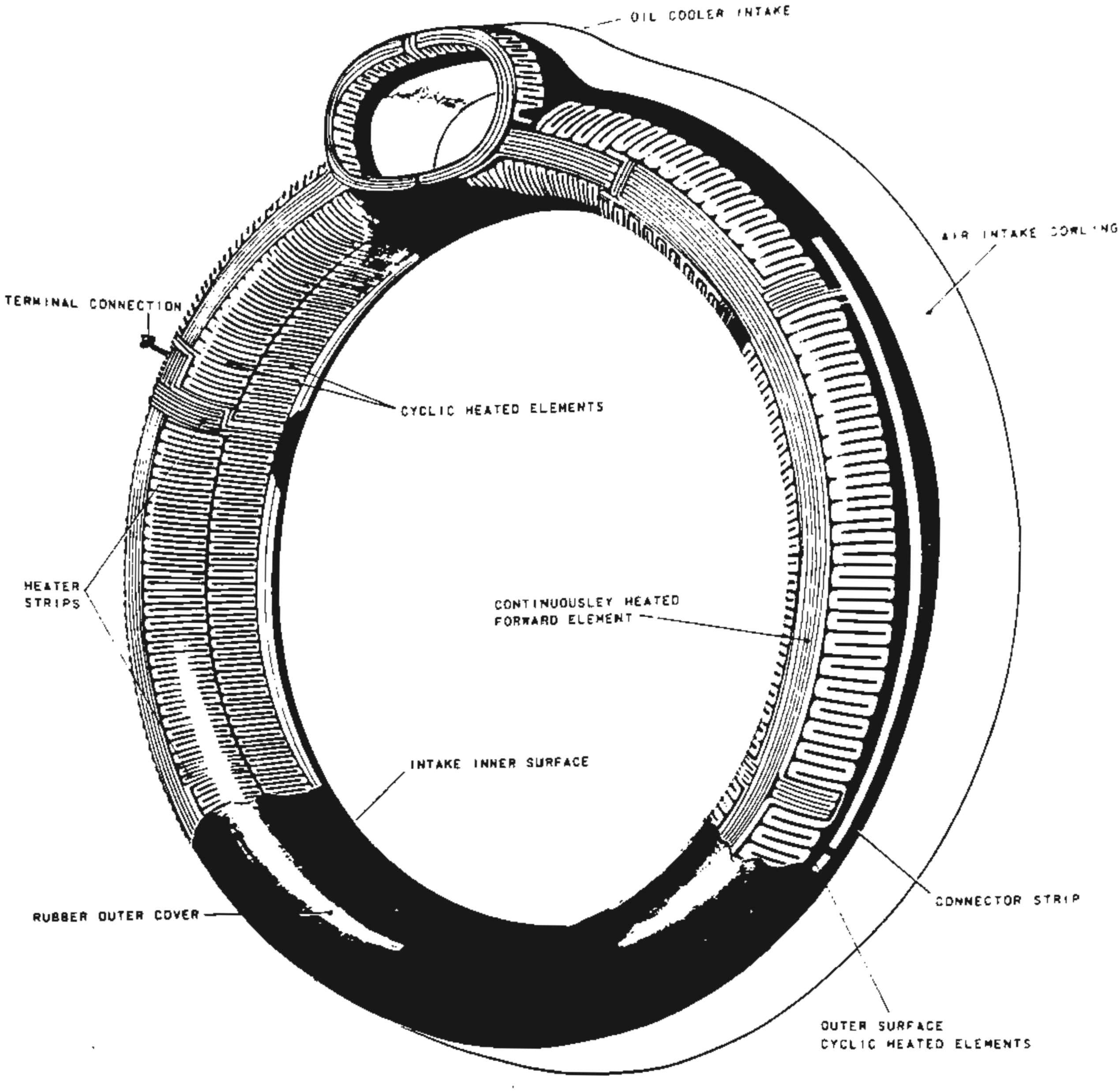
60.4 Power Unit Air-Intake

The engine air-intake heater elements prevent excessive ice formation on the power unit air intake cowling.
The leading edge of the air intake is provided with a continuous heated element having several strips extending aft to the inner and outer sides of the air intake cowling.
The intermittently-heated elements are situated between and behind the continuously heated strips.

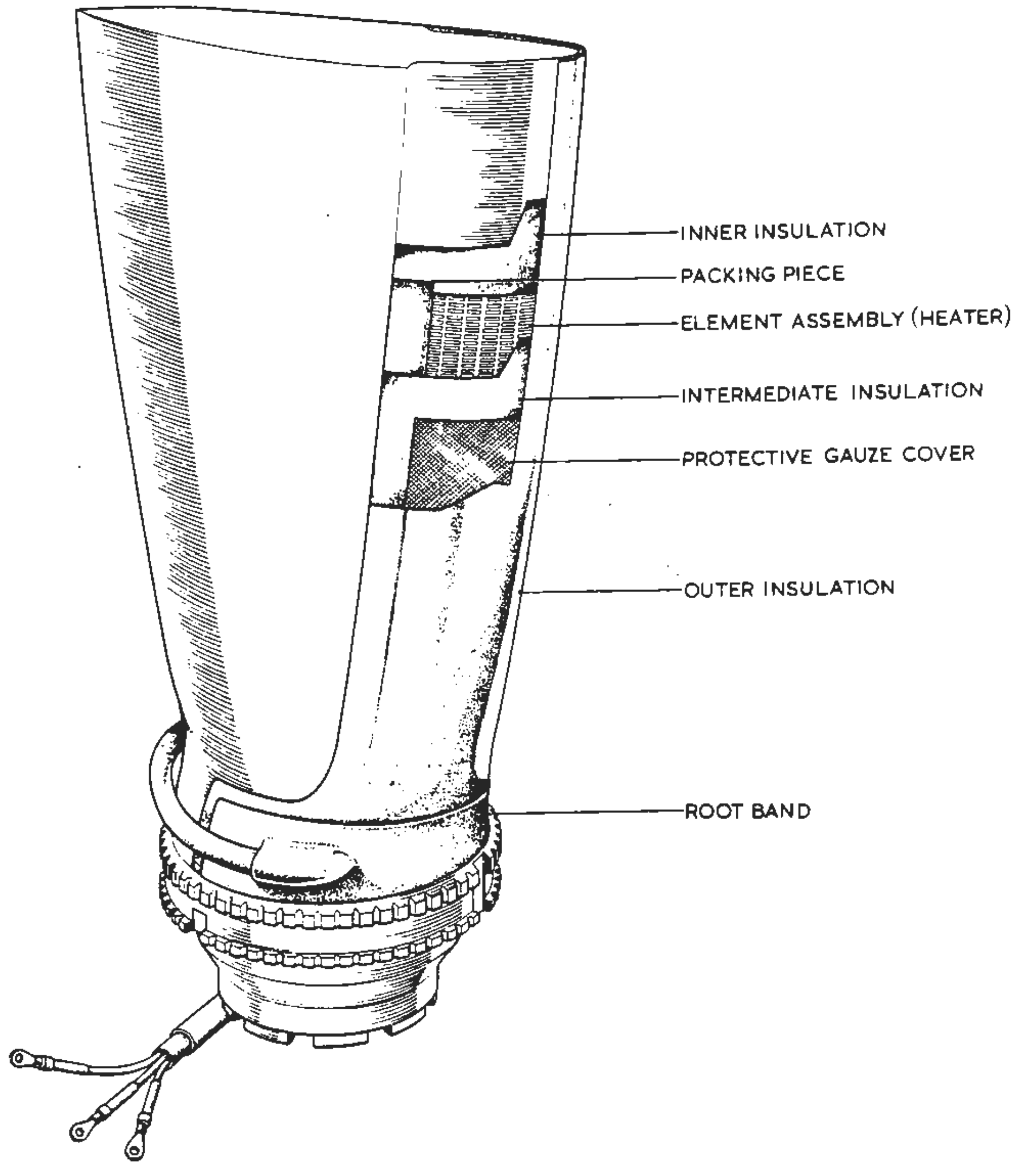
60.5 Spinner and Propeller Heater Elements

The elements are intermittently heated and operated in the same way as the intermittently heated elements of the power unit air intake.

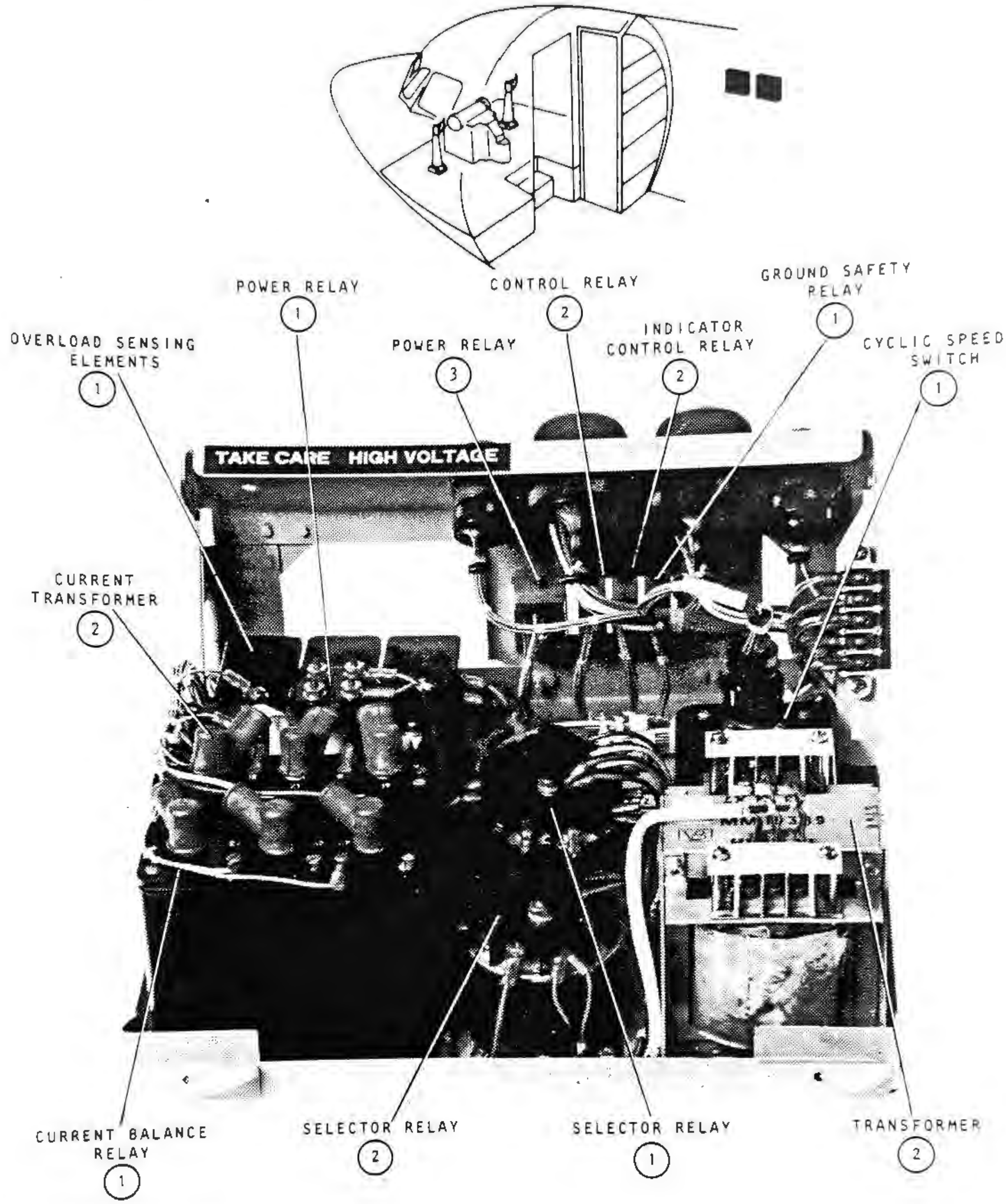
END



ENGINE AIR-INTAKE HEATER ELEMENTS

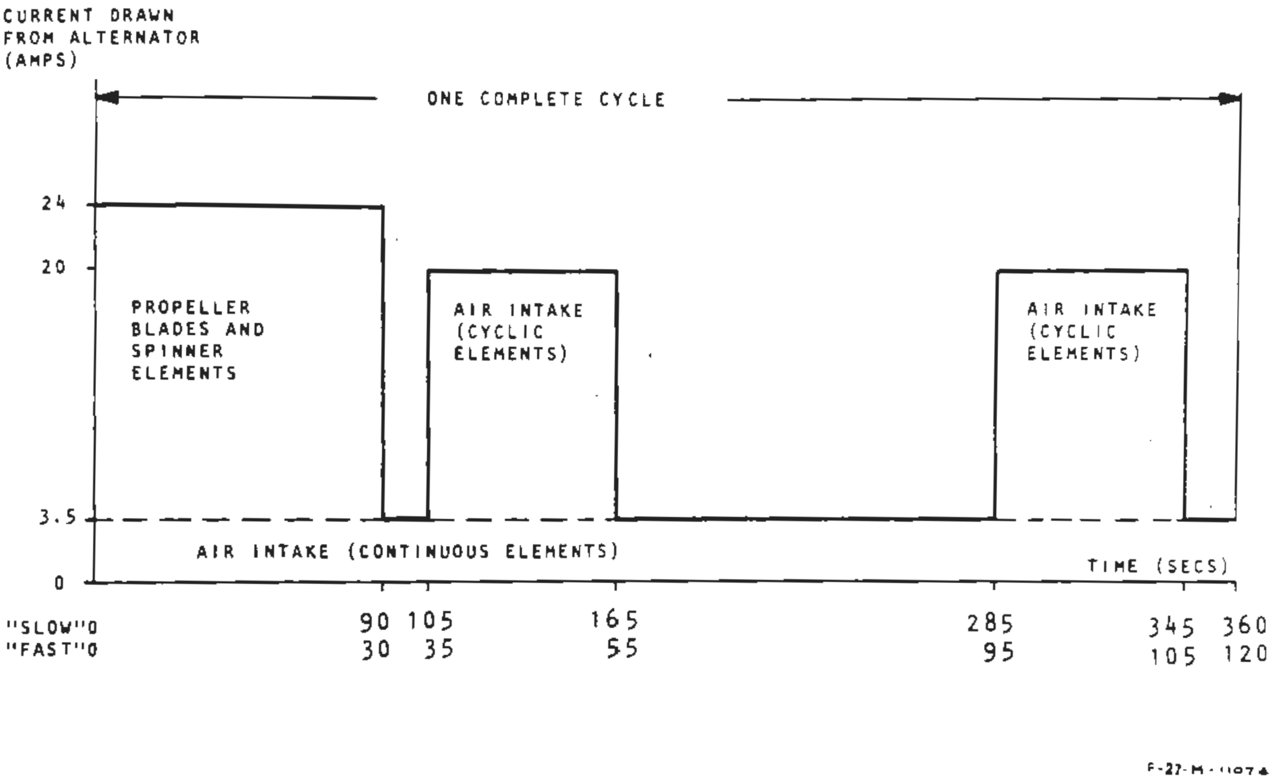


PROPELLER BLADE DE-ICING ELEMENTS

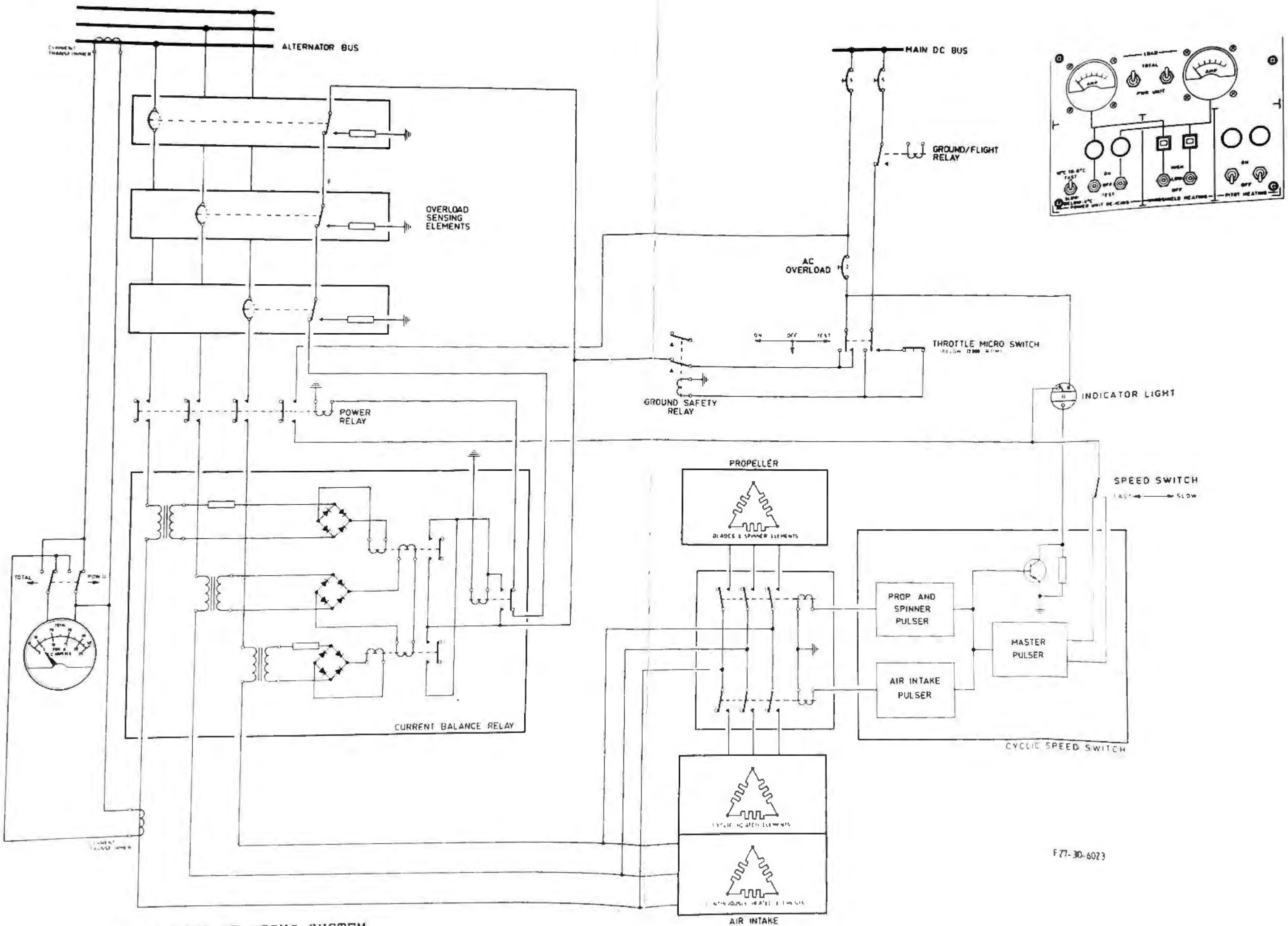


1 POWER UNIT DE-ICING
2 WINDSHIELD ANTI-ICING
3 EXTRA COCKPIT HEATING

DE-ICING RELAY PANEL



POWER UNIT DE-ICING CYCLING SCHEME

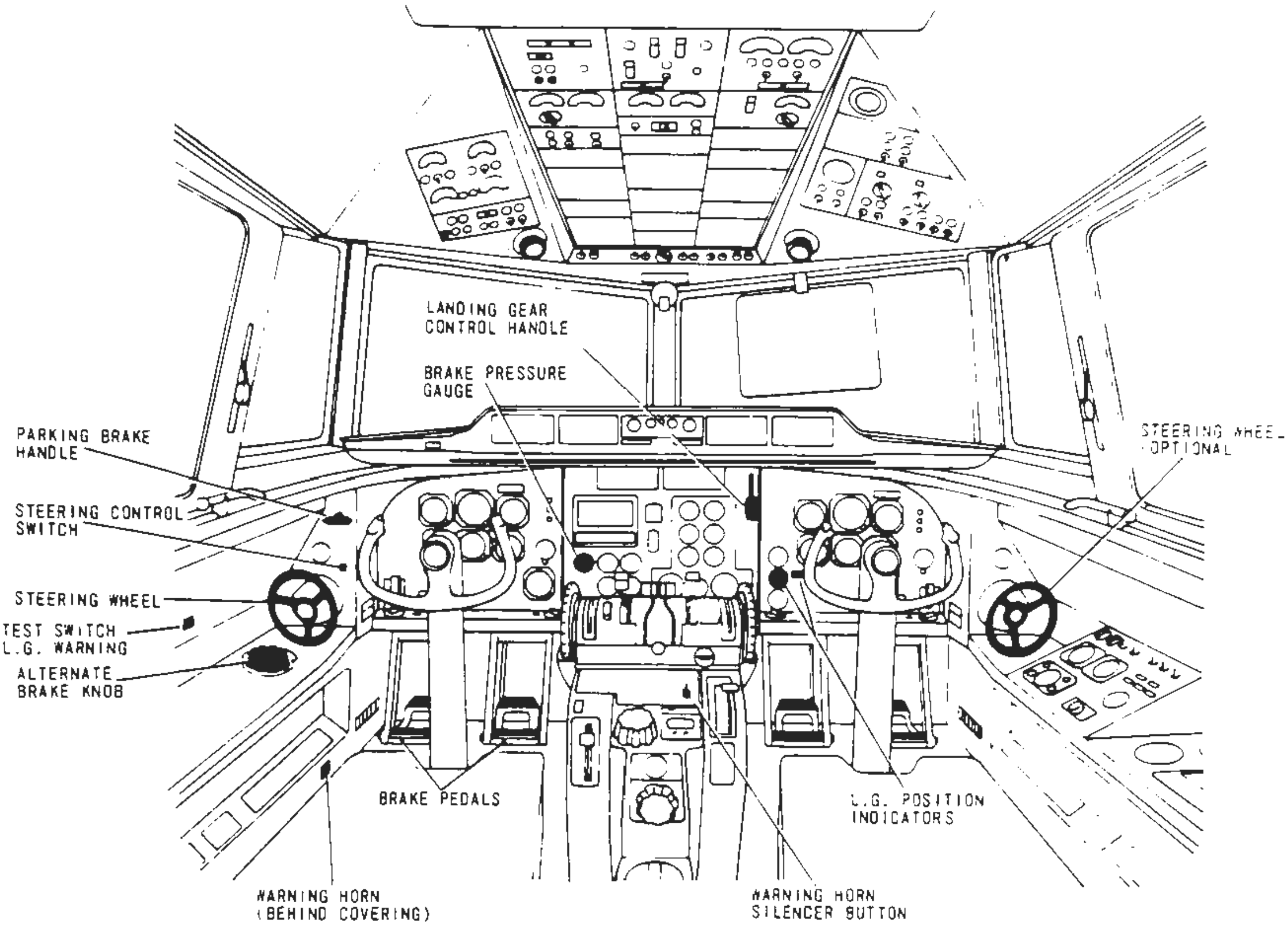


POWER UNIT DE-ICING SYSTEM

LANDING GEAR

32

32. LANDING GEAR



LANDING GEAR - CONTROLS & INDICATORS IN COCKPIT

32. LANDING GEAR

00. GENERAL

The fully retractable, tricycle landing gear consists of a main gear with dual wheels within each nacelle and a steerable nose gear with a single wheel in the fuselage nose section.
When retracted, each gear is completely enclosed by mechanically operated doors.

Gear operation is accomplished by pneumatic power and controlled from the cockpit by the landing gear control handle on the main instrument panel. This handle is locked in the DOWN position as long as the aircraft is on the ground.

Up- and downlock assemblies, which secure the gears mechanically in the retracted and extended positions are pneumatically released; the uplock assemblies by separate rams and the downlock assemblies by the initial movement of the gear actuating rams.
Should the normal operating system fail, the uplock assemblies can be released and the landing gear extended by an alternate system, which is completely isolated from the normal system.

When the airplane is on the ground, safety (ground) locks with a red streamer are to be inserted in the downlock mechanism of the nose and main gears, to prevent inadvertent unlocking.

The main gear wheels are equipped with pneumatically actuated brakes and Maxaret anti-skid units. In case of failure of the normal operating system, power for the brakes may be obtained from an alternate system which is also completely isolated from the normal system. However, in this case the Maxaret anti-skid units and differential brake control valve are by-passed.

Nose wheel steering is accomplished by a pneumatic steering system with pneumatic centering and damping.

Landing gear position indicator lights operated by microswitches on up- and downlock assemblies provide the flight crew with all necessary gear position indication.

The majority of the pressure regulating and controlling components used in the pneumatic systems are mounted on a pneumatic panel, located in the pneumatic compartment on the left-hand side of the front compartment.

The main gears are provided with jacking studs for wheel replacement. Both nose and main gears have provisions for towing and mooring.

10.0 MAIN GEAR AND DOORS

The main landing gears are attached to fittings in each nacelle and retract into the nacelles. The landing gear doors are operated by mechanical linkages. Each gear consists of an upper member, shock strut assembly, drag strut, lock strut, uplock assembly and dual wheels with brakes.

10.1 Upper Member

The upper member is H-shaped with its upper arms attached to the wing fittings and its lower arms attached to the shock strut. The uplock assembly is mounted on the upper member. (On gear retraction the upper member rotates forward.)

10.2 Shock Strut

The shock strut is of the hydraulic-pneumatic type and consists of an outer cylinder and a sliding member, telescoped together. A pair of hinged torque links are connected between the outer cylinder and the sliding member to prevent rotation of the sliding member in the outer cylinder and to ensure lateral rigidity.
Lugs are provided at the top of the outer cylinder for attachment of the lock strut and at the lower end for attachment of the drag strut.
Door engaging bars, towing and mooring lugs and an uplock roller are bolted to the outer cylinder. A charging valve permits servicing of the strut.
The lower end of the sliding member carries the axle which is provided with drilled flanges for the attachment of the brake unit torque plates. A jacking stud is screwed in the bottom of the sliding member to allow for wheel replacement. The strut is filled with hydraulic fluid and compressed nitrogen. The static weight of the aircraft is carried by the nitrogen in the upper part of the strut.
Impact energy during landing and taxying is absorbed by the hydraulic fluid in the lower part of the strut and by compression of the nitrogen. Fluid is metered to give a fast compression rate and a slow recoil.

10.3 Drag Strut

The drag strut is the longitudinal bracing member of the gear assembly and is attached between the forward wheel bay bulkhead and the lower end of the shock strut. It consists of a tube closed at the ends by attachment fittings. The fittings at both ends are secured by ferrules, tie-rods and nuts.
A Maxaret protector is installed to the lower end of the drag strut.

10.4 Lock Strut

The lock strut is used to lock the main gear in the down position and consists of front and rear subassemblies connected together at their inner ends.
The other end of the front subassembly is connected to the drag strut while an adjustable eye bolt screwed into the outer end of the rear subassembly, and locked in position by a lock nut, is connected to the upper end of the shock strut.

A platform, bolted to the inner end of the rear subassembly together with a microswitch bracket, allows the joint to break in one direction but restricts hinge movement in the opposite direction by abutment against the side members of the front subassembly.

Shims are fitted under the platform for adjustment of the locked position of both assemblies.
A locking bar fitted transversely through the forward end of the rear subassembly engages with a spring-loaded latch of the downlock mechanism in the front subassembly when both subassemblies are aligned and the joint abuts. The latch is connected to an operating lever by a spring-loaded latch bolt. The operating lever is actuated by a trunnion to which is connected the main gear actuating ram. The spigots of the trunnion are located in slots in the side members of the lock strut front assembly.

During retraction, initial movement of the main gear actuating ram piston will move the trunnion upwards in the slots, thus withdrawing the latch against its springload to allow the lock strut to fold.

The downlock switches for the main gear are installed on the rear part of each lock strut and operated when the lock strut is fully down and the locking latch installed on the forward part of the locking strut is moved to lock both parts of the locking strut.

Red indicator lines are painted on both subassemblies of the lock strut. If the landing gear indication does not show down and locked for each main gear after extension the following visual check can be carried out through one of the cabin windows:

The red painted lines on the lock strut must be in the aligned position. This indicates that the lock strut is in the proper down position. The position of the trunnion in its slotted opening is to be checked. When this trunnion is in the down position (bottom position in slot) the latch snaps into position over the latch bar by spring force with the lockstruts aligned, thereby locking the main gear in the down position.

If the red lines are not aligned and/or the trunnion is not in the down position the relevant main gear is not locked down.

10.5 <u>Uplock Assembly</u>

The assembly is installed on the H-member and consists of a springloaded pneumatic uplock ram connected to a latch by an operating lever and a central lever. A spring-loaded striker lever pivoted on the latch engages a cutout on the central lever and retains the latch in the unlocked position when the ram has opened the latch (down pressure), and the uplock roller on the shock strut is out of the latch. When the landing gear is selected UP, the down pressure is released and due to its springload the uplock ram tends to move the assembly to the locked position. The striker lever still retains the assembly in unlocked position. However, during final stage of retraction the uplock roller on the shock strut operates the striker lever which unlocks the assembly allowing the ram to move the latch to its locked position to engage the roller. The operating lever operates microswitch II and the striker lever actuated by the uplock roller operates microswitch I. A shuttle valve on the uplock ram is installed so that the normal and alternate supply systems can be used to unlock the lock assembly.

10.6 Uplock Ram Shuttle Valve Test

Since free movement of the shuttles is essential for extension of the landing gear in case of failure of the normal extension system it is recommended to check the serviceability of this shuttle frequently. With the aircraft on the ground - groundlocks installed and normal selector handle DOWN:

a. Close the isolating valves and deflate the landing gear down system by the use of the discharge valve on the pneumatic panel.
b. Bring the main gear uplock units to the locked position and check that the nose gear uplock unit is in this position (held in locked position by springforce).
c. Select alternate down and check that all three locks are unlocked thus indicating proper operation of the shuttle valves.
d. Re-open isolating valves and reset alternate landing gear handle to normal.
e. Check and charge storage bottles -if required.

10.7 Actuating Ram

A double-acting, grease-or fluid-dampened pneumatic ram is attached between the forward bulkhead of the wheel bay and the lock strut of the main landing gear. On retraction, initial movement of the ram opens the downlock latch to allow the lock strut to fold upwards. A shuttle valve is incorporated into the bottom of the ram which has the normal and emergency down lines attached to it. A three-line swivel unit connects the pneumatic lines in the nacelle to the bottom side of the cylinder. The piston rod is filled with grease or fluid. During extension or retraction of the gears, this medium is forced through an annular clearance between the inner wall of the piston rod and a stationary damper piston, thus damping the movement. An orifice in the damper piston, which is open during retraction, provides less damping during retraction as compared to extension. The outer end of the piston rod is closed by a plug, the latter being provided with a bleed screw. A passage is drilled in the eye end to detect grease or fluid leakage past the plug or bleed screw.

NOTE: If grease is detected in the environment of the eye end/or collector plate it is recommended to clear it and watch for further leakage. If after some retraction cycles grease reappears it means that the ram leaks and should be replaced as this might affect the damping action.

10.8 Doors

Each main gear wheel bay is enclosed by four doors at the sides of the wheel-bay and a small door at the front. The latter is hinged to the forward wheel bay bulkhead and is attached to the drag strut by a clamp.
The doors at the side, assigned as centre and rear doors, are interconnected by hinge brackets. The lower hinge bracket is adjustable. The centre doors are connected to the carriages of the door operating mechanism by means of an adjustable operating rod.

10.9 Door Operating Mechanism

The main gear doors operating mechanism consists of a track and carriage assembly on each side of the wheel bay. Each carriage is connected to the doors on its respective side by an adjustable push-pull rod. A latch incorporated in the carriage engages a slot at the lower end of the track to hold the doors in the open position.

To prevent unlatching when the doors are open and locked down, an abutment consisting of an adjustable bolt on the carriage unit and a stop bracket on the landing gear upper member restrict downward movement of the carriage unit. The track roller of the latch is held in this position by a detent cam in the slot and a spring-loaded stop pin, which tends to move the carriage upwards. The lower outboard guide rollers are adjustable to take up any clearance between carriage and track. On retraction, the operating bars on the shock-strut engage the carriages, thereby disengaging the latches from the slots in the lower ends of the tracks and pulling them up the tracks to close the doors. Red indicator lines on the carriages and on the latch will be aligned when the latch is in the correct down position.

10.10 Servicing Shock Strut

Filling and charging can be carried out with either the landing gear under static load or with the aircraft jacked up. In the first case a pressure/extension graph is used. In the second case the nitrogen pressure is checked with the strut hydraulically full in accordance with the figures given in the maintenance manual.

10.11 Ground/flight Switch (Shock Strut Microswitch)

A ground/flight switch is mounted in each main gear shock strut triangle and actuated by an adjustable bolt on the top manifold of the lower pneumatic swivel unit.

These ground/flight switches are used for various systems which are operated either on the ground or in flight.

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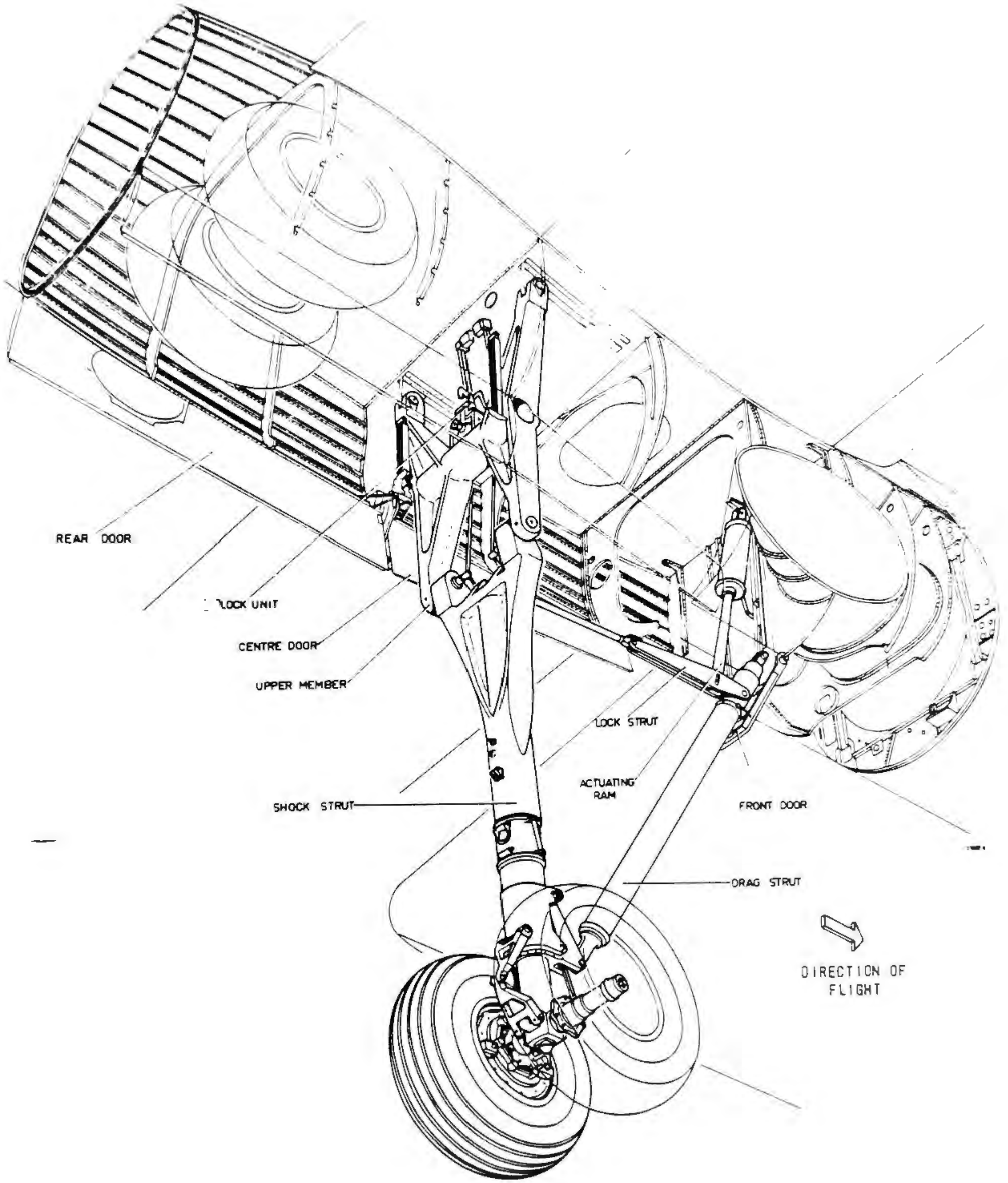
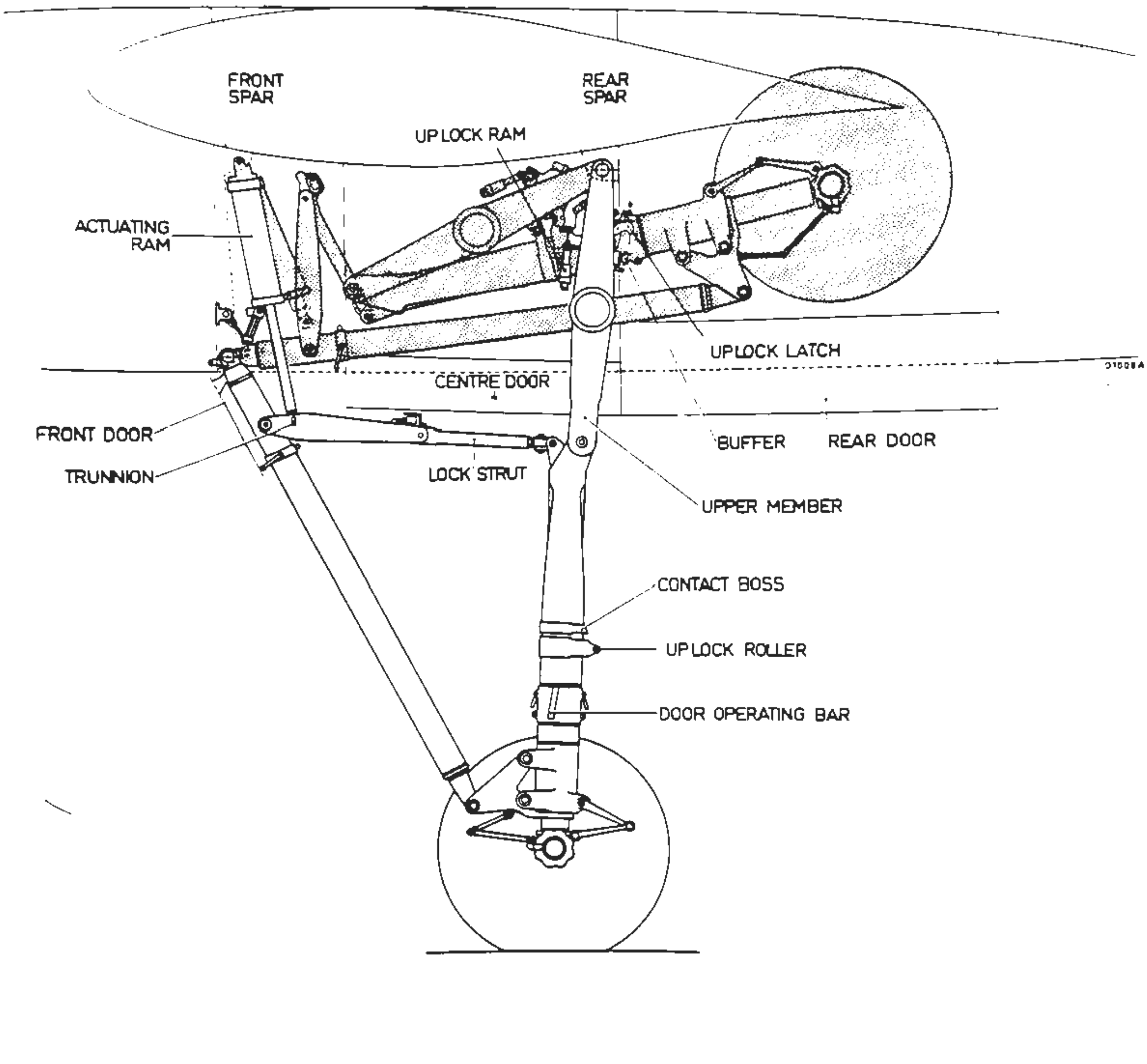
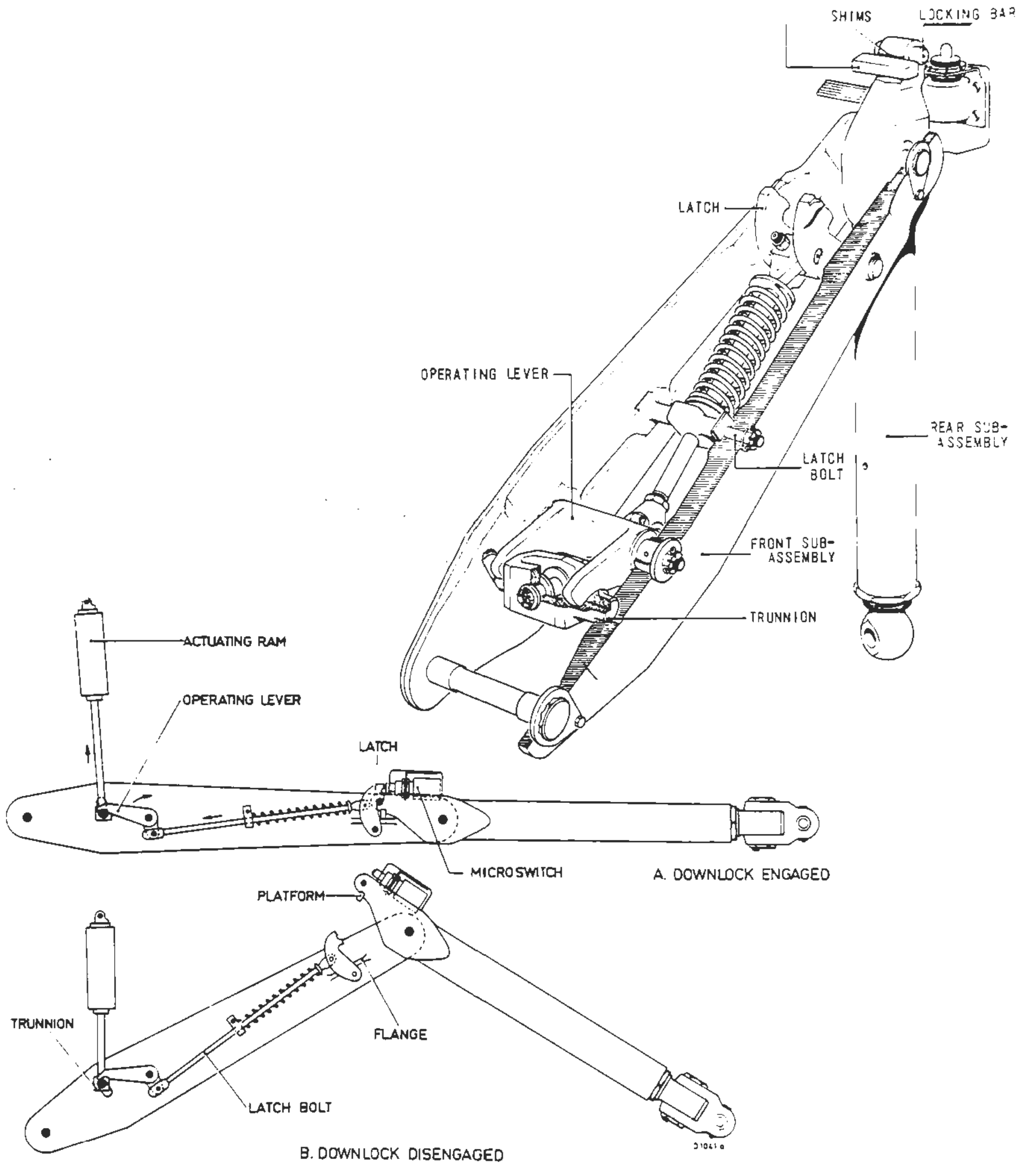


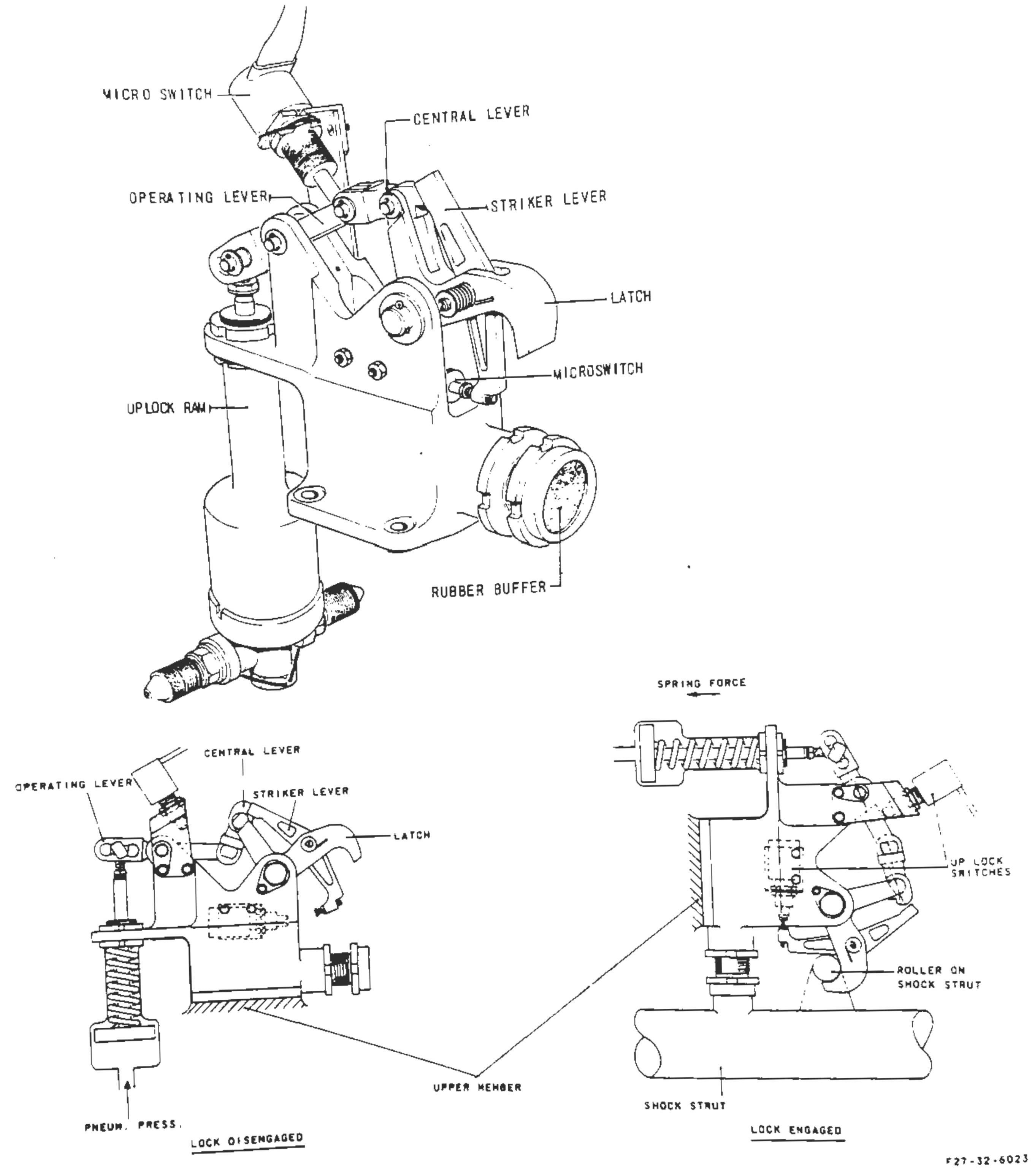
MAIN LANDING GEAR



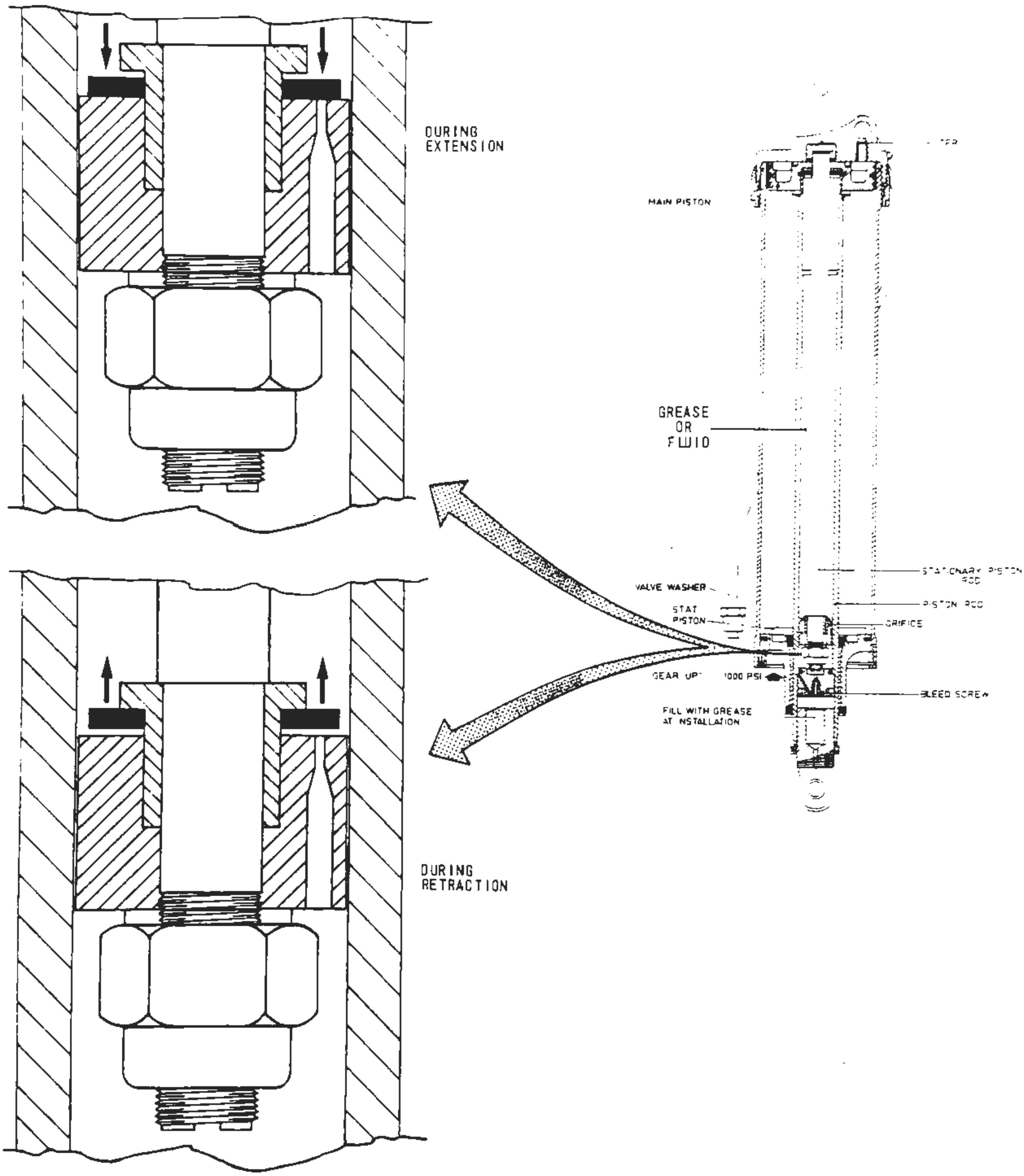
MAIN LANDING GEAR KINEMATICS



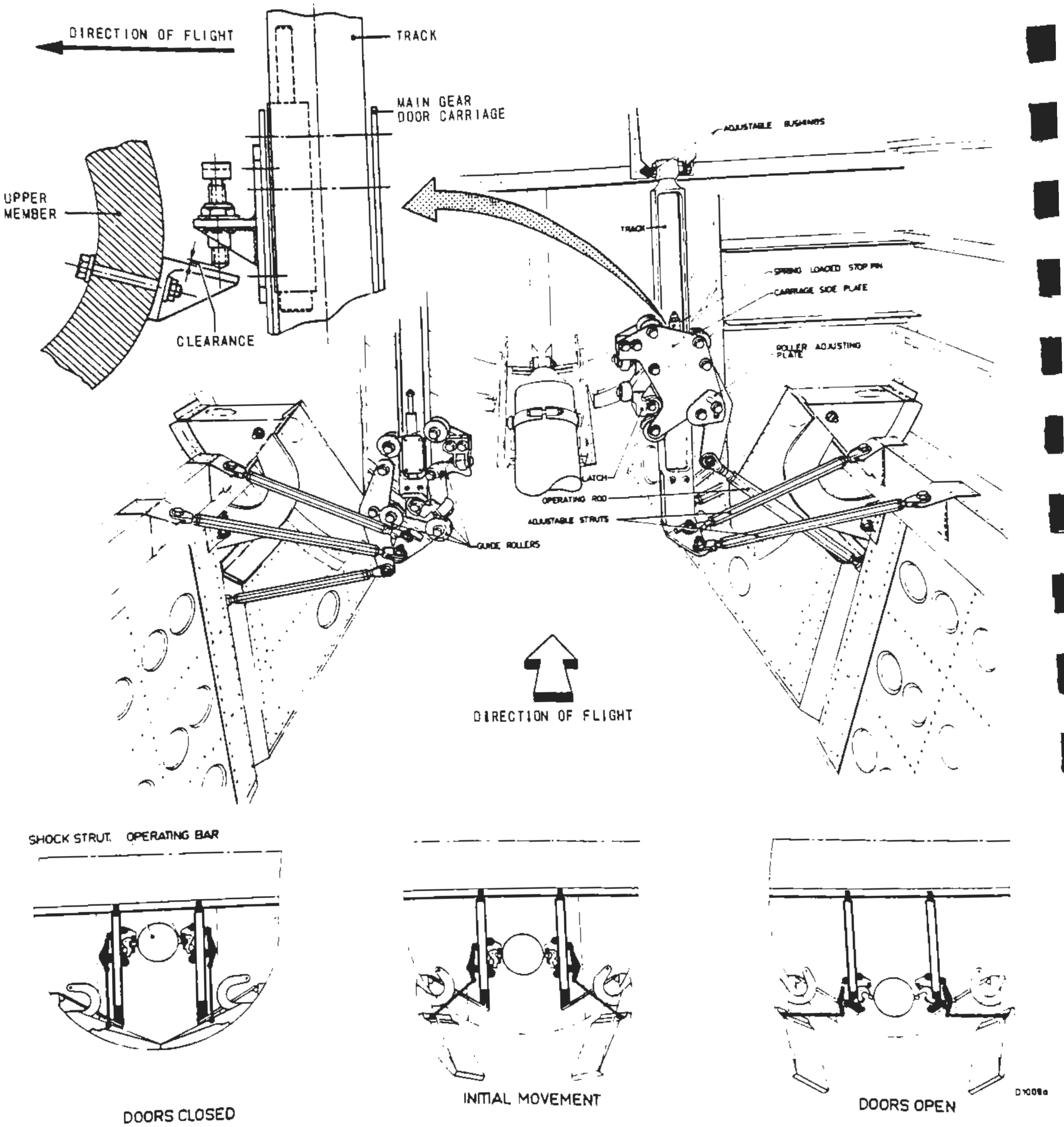
MAIN GEAR LOCKSTRUT AND DOWNLOCK



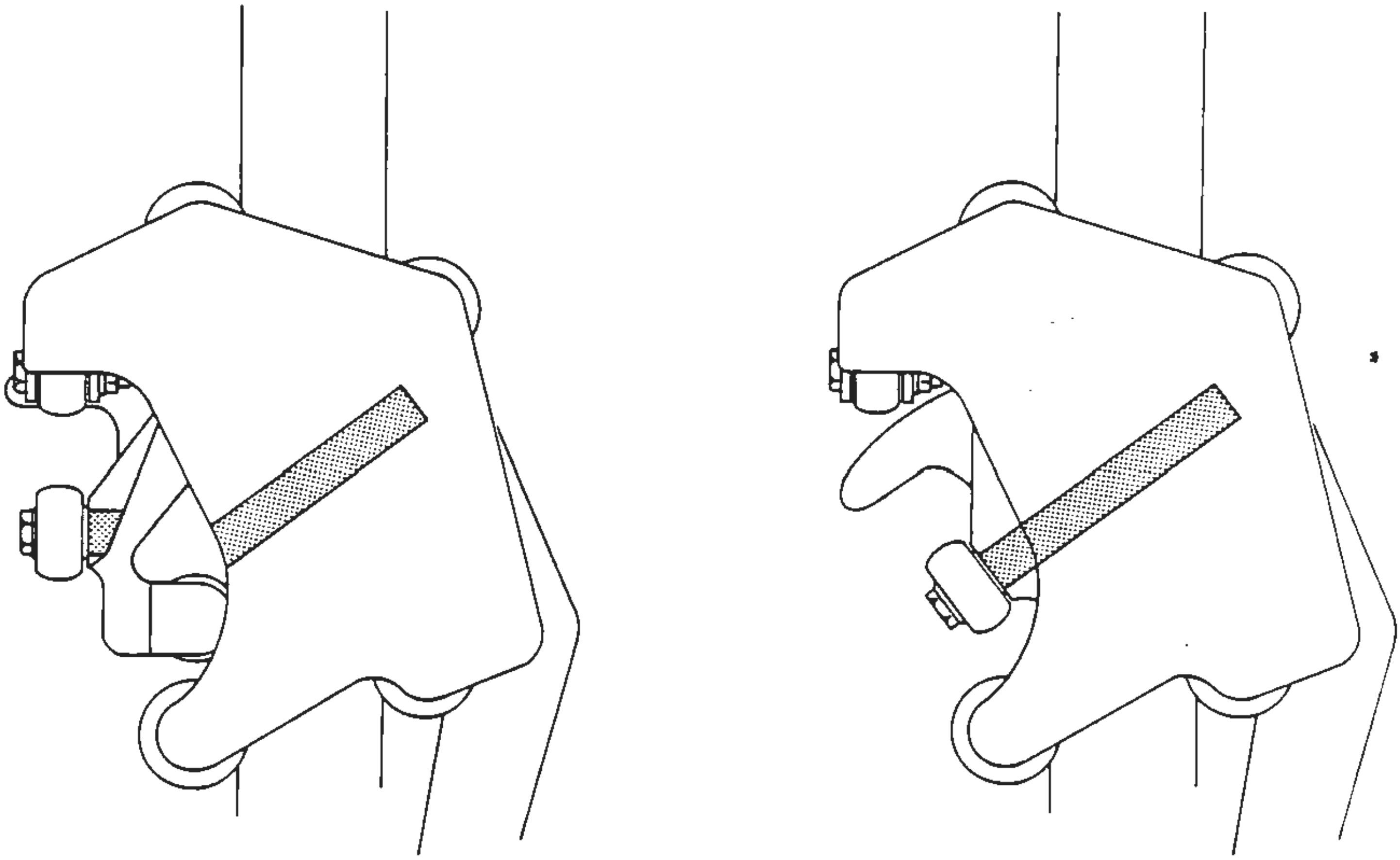
MAIN GEAR UPLOCK



MAIN LANDING GEAR - ACTUATING RAM



MAIN LANDING GEAR - DOOR ACTUATING MECHANISM



RED

D 1202

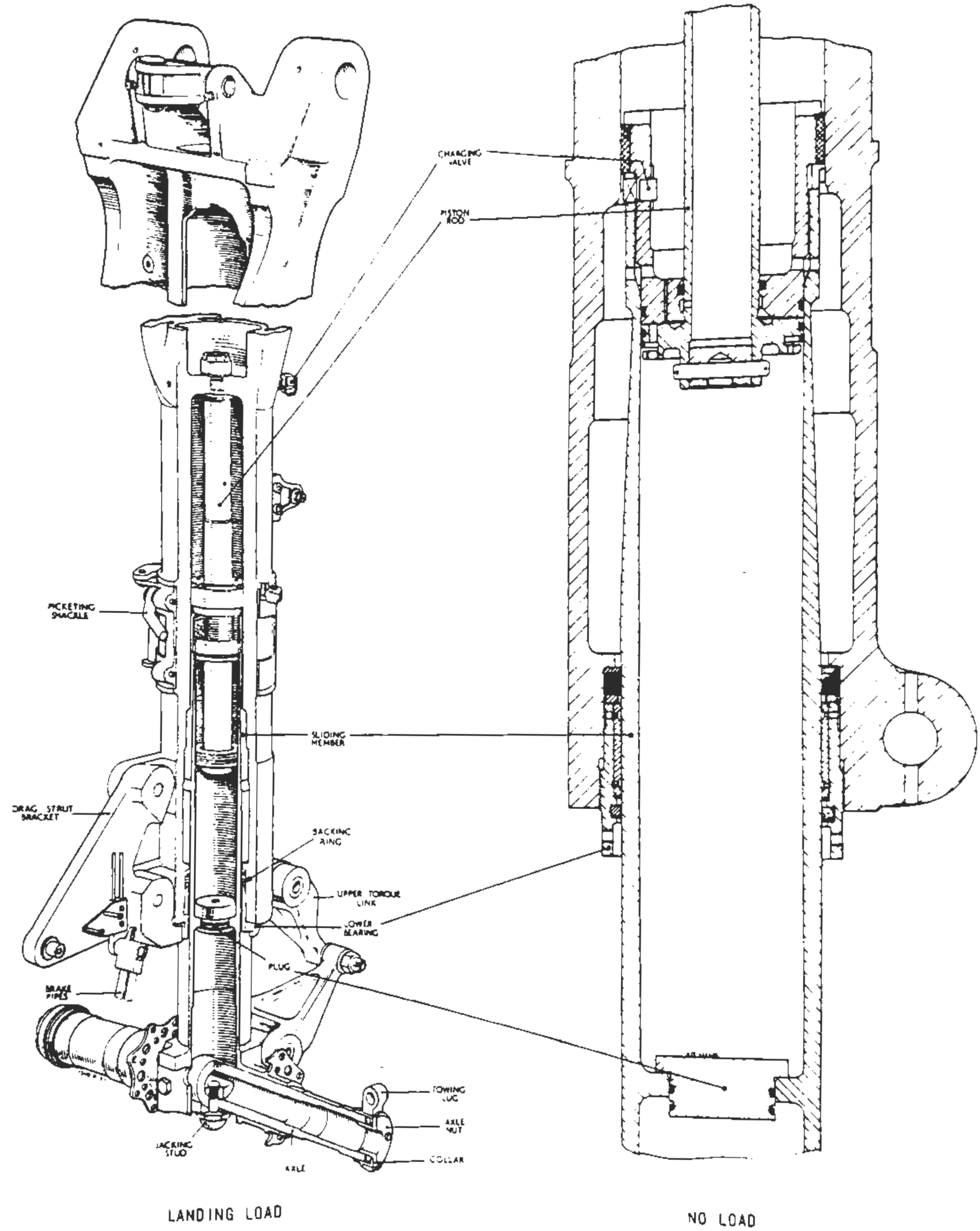
DOORS OPEN BUT NOT LOCKED

RED LINE IS BROKEN

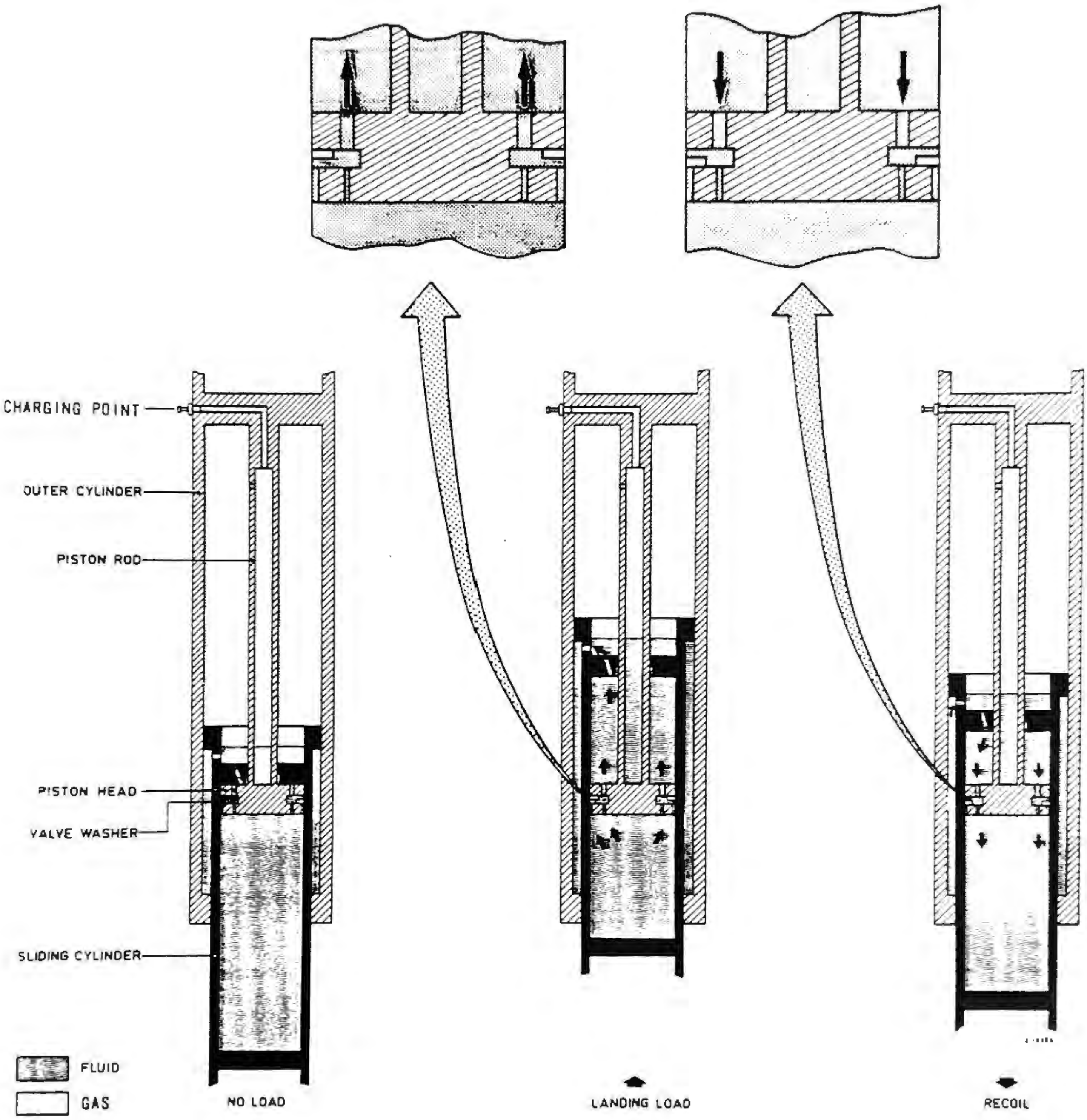
DOORS OPEN & LOCKED

RED LINE IS STRAIGHT

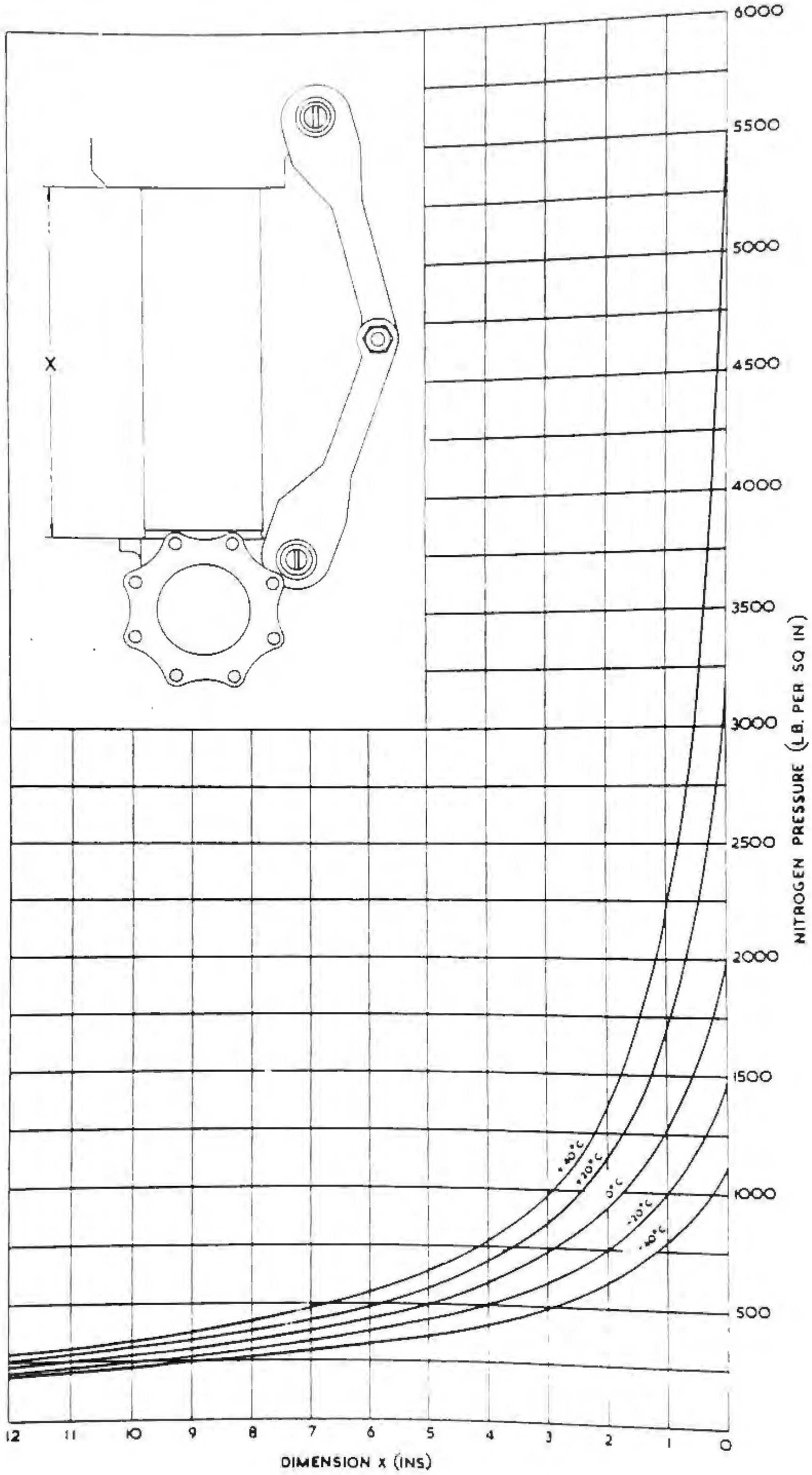
MAIN LANDING GEAR DOOR CARRIAGE MARKING



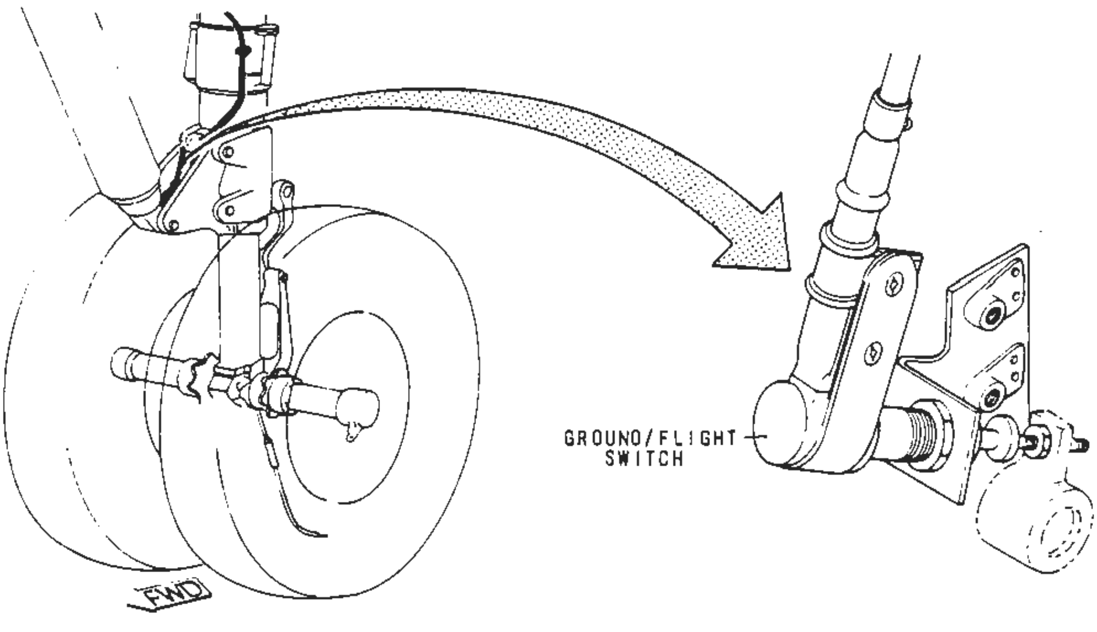
MAIN LANDING GEAR - SHOCK STRUT



MAIN GEAR SHOCK ABSORBER - PRINCIPLE OF OPERATION



MAIN GEAR SHOCK ABSORBER PRESSURE/EXTENSION GRAPH



MICROSWITCHES ON LANDING GEAR SHOCK STRUTS

20.0 NOSE GEAR AND DOORS

The nose gear is of the levered suspension type and consists of a:

a) Main fitting which is the upper part of the nose gear and is used to attach the nose gear to the nose gear fittings on the forward pressure bulkhead. Connected to the main fitting is the actuating ram retracting the gear in forward direction, a steering mechanism, a downlock mechanism and an uplock bracket.
b) Pivot bracket fitted vertically through the centre of the main fitting and supported by bearings. A shimmy damping assembly is fitted between the pivot bracket and the main fitting. The steering mechanism is directly mounted to the pivot bracket.
c) Wheel lever which in the middle is connected to the pivot bracket. At the lower side it houses the nose wheel.
d) Shock absorber which takes up the impact during landing and taxying is installed between the pivot bracket and the wheel lever.

20.1 Downlock Mechanism

This mechanism consists of a retraction crank operated by the actuating ram. This crank is provided with a profile and pivots on the main fitting which has an abutment. The crank also operates a mechanism connected to a downlock latch.

The downlock latch moves over a downlock pin and is held in the locked position by springforce. The downlock pin is part of a downlock block attached to the RH side of the nose gear fitting.

Three microswitches are fitted in the nose gear downlock mechanism and are actuated when the downlock is engaged. One is attached with a bracket to the right-hand inner side of the main fitting (microswitch III) and is actuated by a striker plate, connected to the tie rod. Two microswitches are connected to a bracket that is bolted to the downlock block. One is actuated by a striker plate on the main fitting (microswitch II), the other switch (microswitch 1) is situated on the right-hand side of the downlock block and actuated by a striker lever.
An internally bushed hollow bolt is secured through the downlock block and the fitting. The hollow bolt houses a springloaded operating lever which is connected to the microswitch striker lever. The operating lever is operated by the downlock latch during engagement.

When an up selection is made the initial movement of the actuating ram rotates the operating crank thereby unlocking the downlock latch. Simultaneously the profile travels and when it abuts the nose gear is unlocked. Further movement is transmitted to the main fitting thereby retracting the nose gear. When extending the gear the downlock latch remains open and moves to the locked position by springforce when the gear is fully down.

20.2 Uplock Unit

This unit is installed on the front pressure bulkhead and consists of a latch, an uplock ram and a striker to operate the uplock microswitch. When the nose gear is retracted the uplock bracket will slide under the uplock latch.
This latch is spring-loaded to the locked position by means of a spring inside the uplock ram. The striker operates the uplock microswitch via the uplock bracket. Unlocking is accomplished pneumatically via the uplock ram. A shuttle valve on the uplock ram is used to unlock the nose gear by either the normal or the alternate system.

20.3 Uplock Ram Shuttle Valve Test

This shuttle valve can be tested in the same way as described for the main gear uplock unit.

20.4 Actuating Ram

This ram is used to unlock, retract and extend the nose gear. The rearward and downward motion of the extending gear is accelerated by gravity and airloads. To counteract this the actuating ram is filled with fluid or grease in the same way as described for the main gear actuating ram.

Nose Gear Doors and Operating Mechanism

Two doors attached to the fuselage nose section are operated mechanically by swivel rods connected to the door closing lugs on the main fitting.

20.5 Shock Absorber

An oleo-pneumatic shock absorber is attached to lugs on the forward face of the pivot bracket and to the upper end of the wheel lever. The unit consists of an outer cylinder and a sliding cylinder telescoped together to operate a damping valve assembly. Hydraulic fluid is contained in the space between outer and sliding cylinder and in the lower position of the sliding cylinder. Nitrogen is compressed in the upper portion of the sliding cylinder and separated from the fluid by a floating piston. A nitrogen charging valve is mounted at the top of the sliding cylinder.

When the landing gear is off the ground the shock absorber is fully compressed. The floating piston is in its lowest position under influence of the nitrogen pressure.

With the application of the landing load to the gear, the leverage of the wheel fork extends the shock absorber. Fluid in the outer cylinder is forced through the holes in the sliding cylinder thereby lifting the piston valve and forcing the floating piston upward to further compress the nitrogen.

The final absorption of the landing shock and the subsequent release or reduction of the load will permit the compressed nitrogen to expand and move the floating piston downward forcing the fluid back into the outer cylinder.

The reverse flow of the fluid will seat the piston valve over the central orifice, thus restricting the flow to the leak holes in the sliding cylinder. This regulates the speed of recoil.

20.6 Servicing of the Shock Absorber

This check is to be carried out with the aircraft under static load. Reference is to be made to the pressure/extension graph. Proceed as follows:

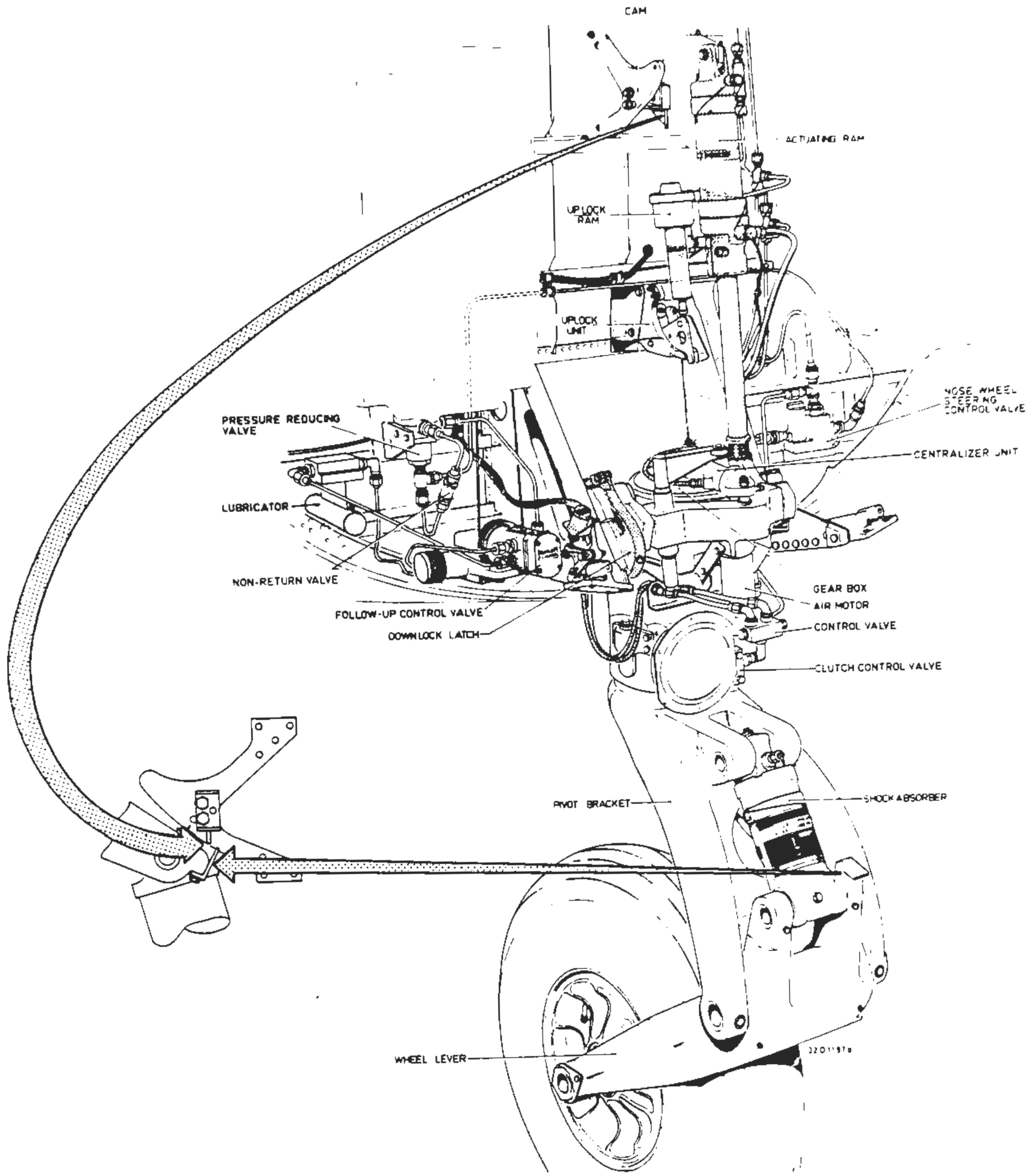
Remove the charging valve cap. Ensure that the release screw of the inflation adaptor is tightened. Screw the adaptor fitted with the extension piece on the charging valve.
Operate the adaptor to open the charging valve. Note the pressure reading on the gauge of the adaptor, measure the extension of the shock absorber and check these against the pressure/extension graph.

NOTE: Loss of oil can be checked by jacking the nose of the aircraft and applying an upward force by hand to the nose wheel. A free stroke of the inner cylinder in the outer cylinder of the shock absorber will indicate a lack of oil.
In this case the shock absorber must be removed to fill it. (Refer to appropriate MM)

20.7 Leakage Indicator

The indicator consists of a fibre glass pin, which will break off in case of an internal leakage of the shock absorber, when the nose gear is in the retracted position. Do not retract the nose gear with a leaking shock absorber since subsequent extension could cause the wheel to damage the doors.

END



NOSE LANDING GEAR

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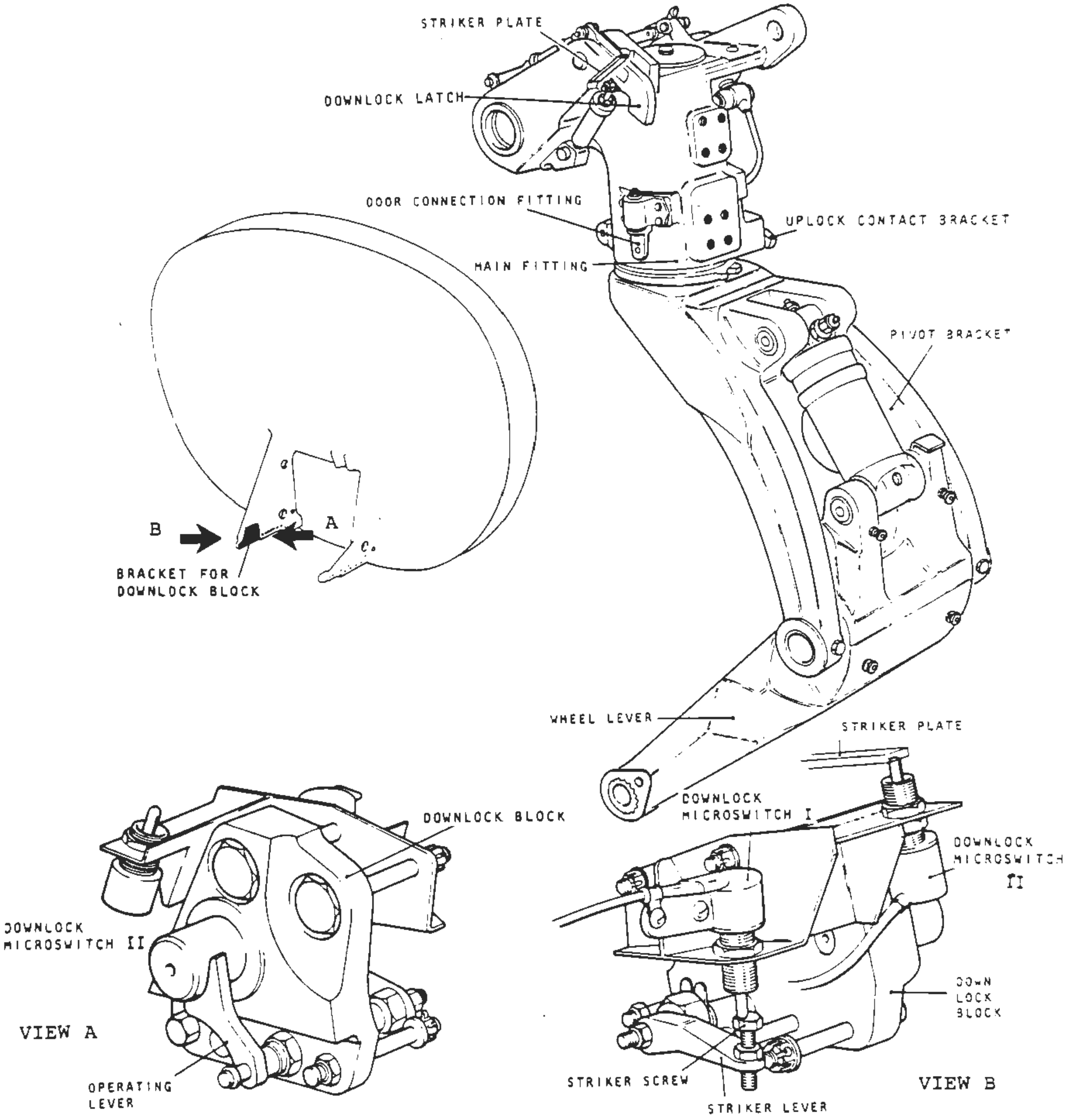
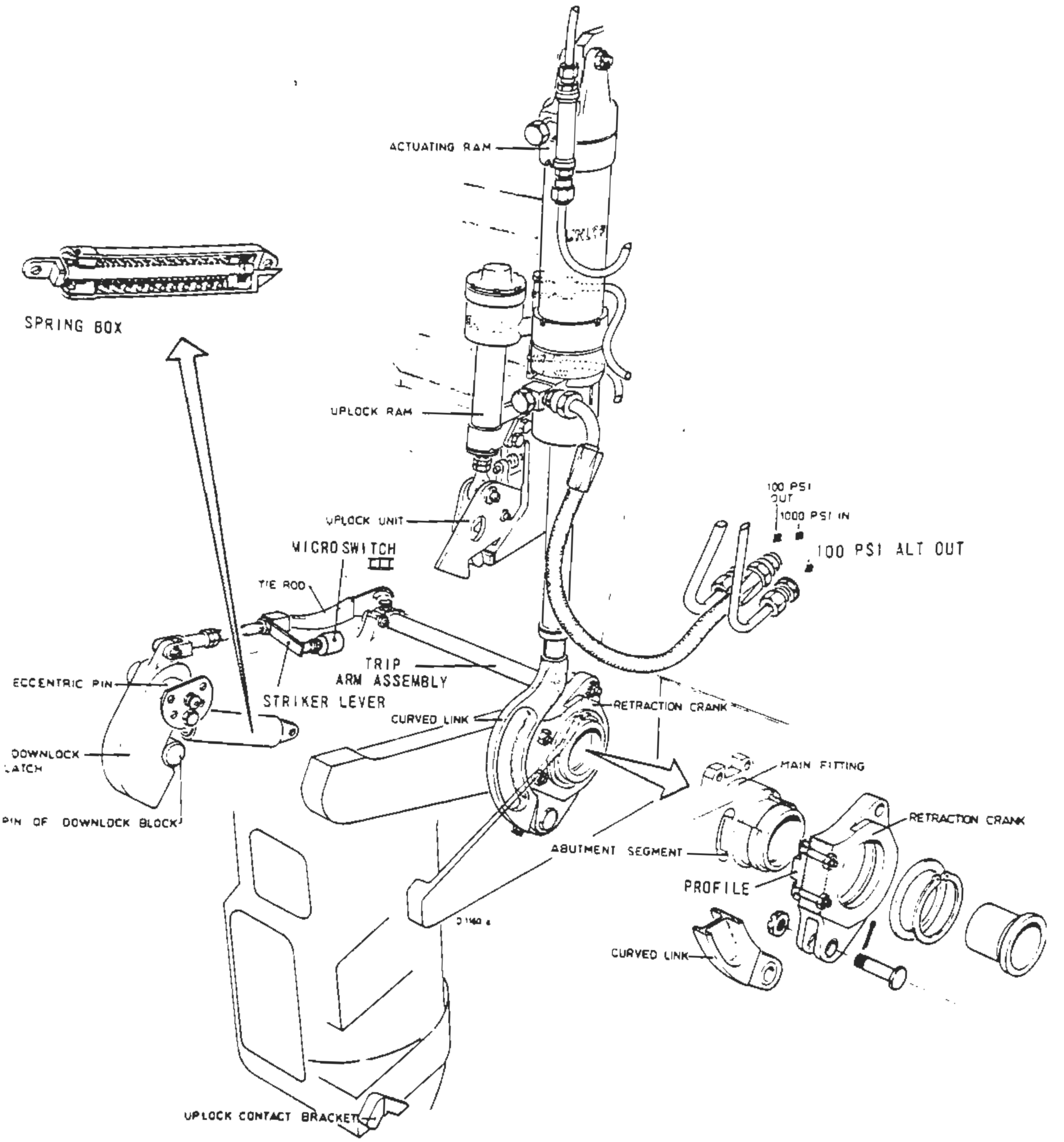
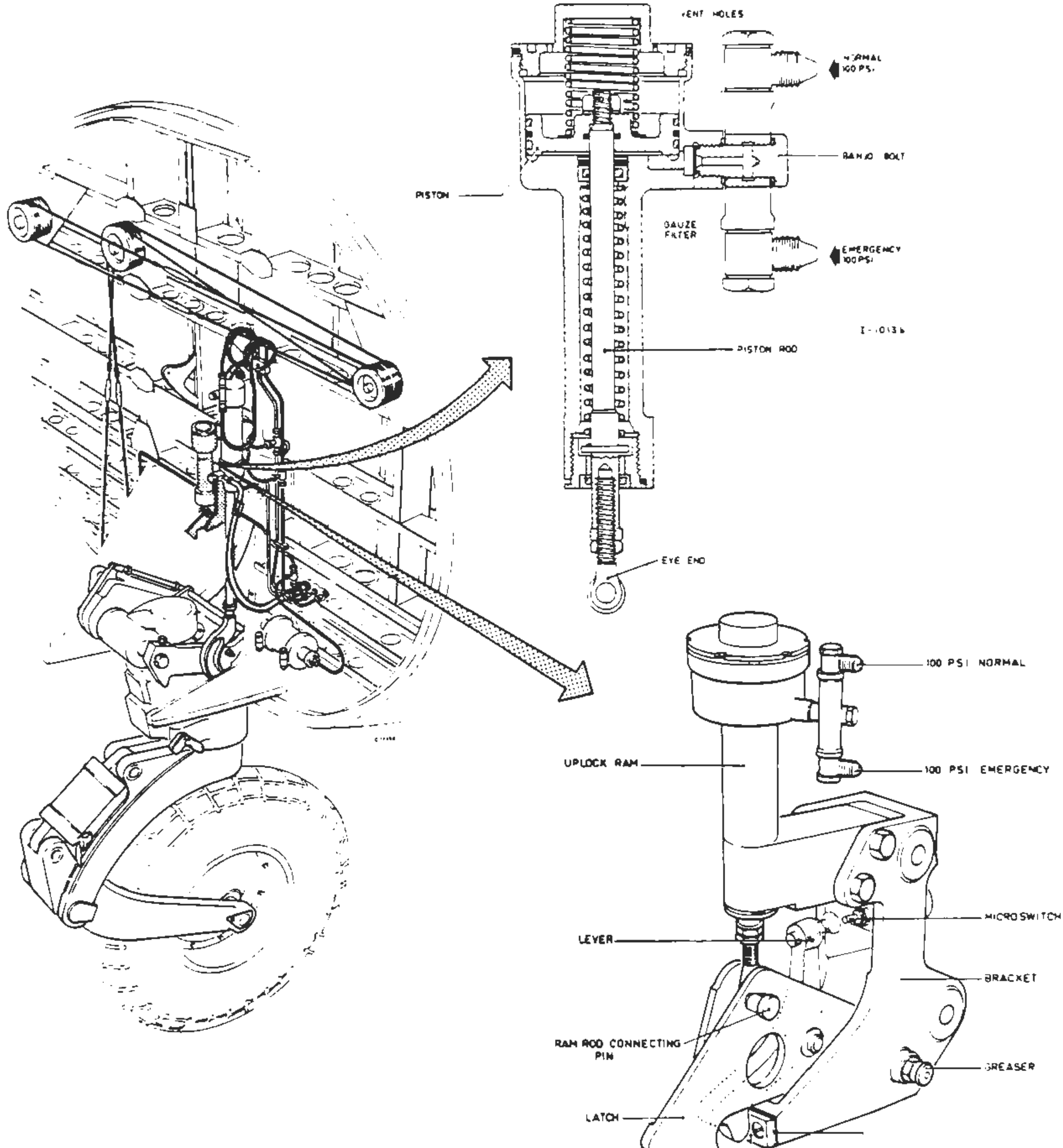


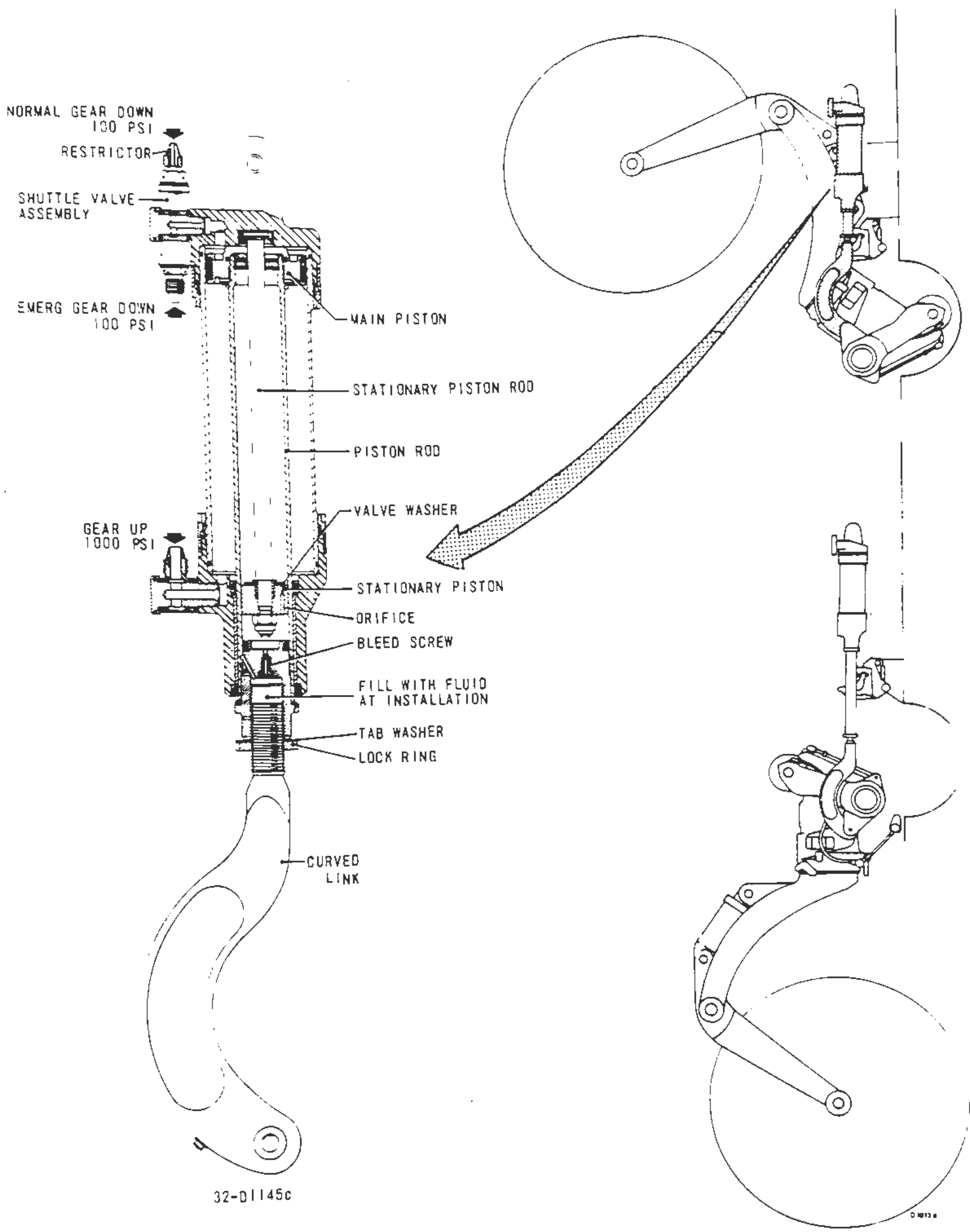
DOWNLOCK BRACKET AND NOSE GEAR COMPONENTS



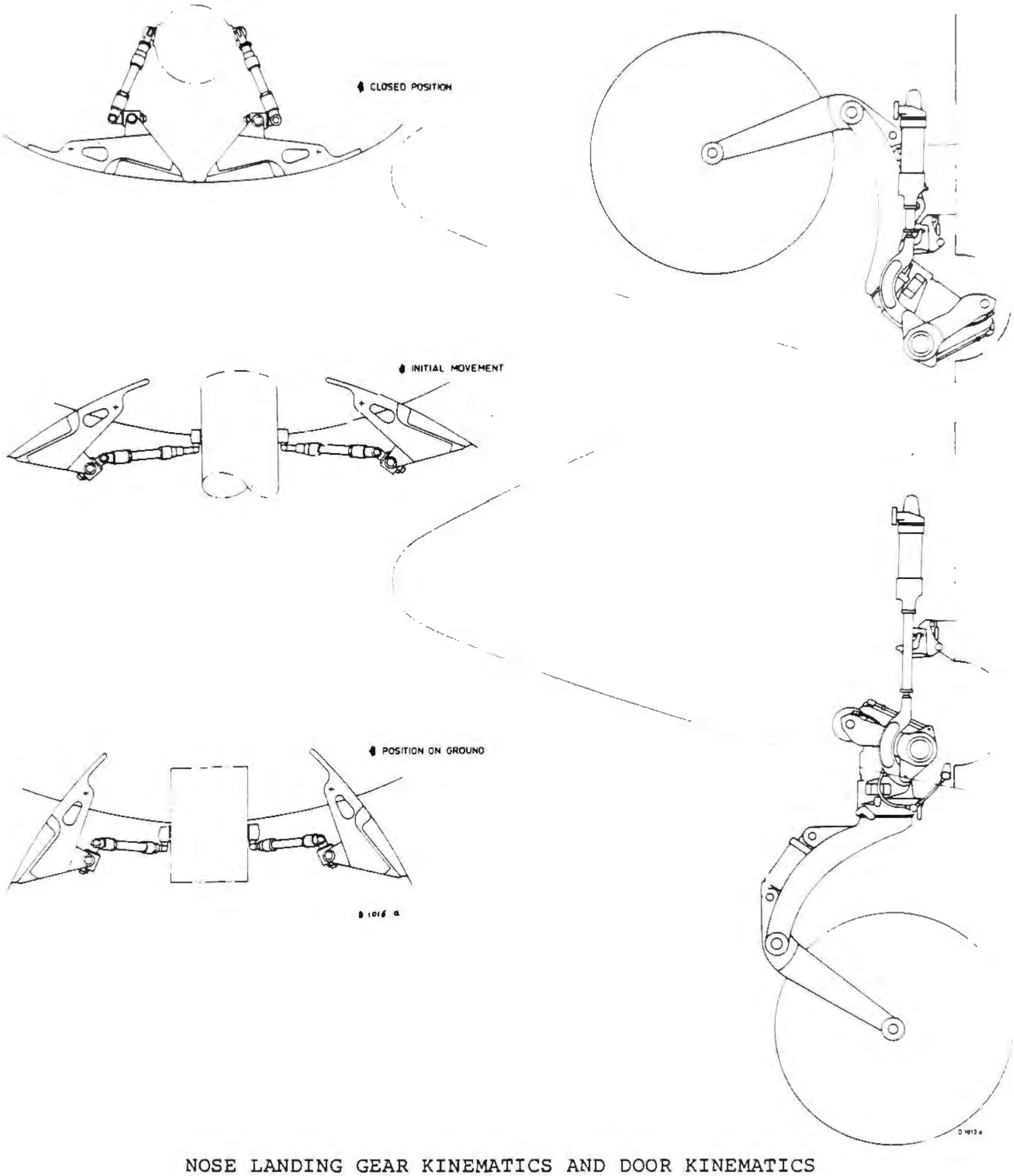
DOWNLOCK MECHANISM



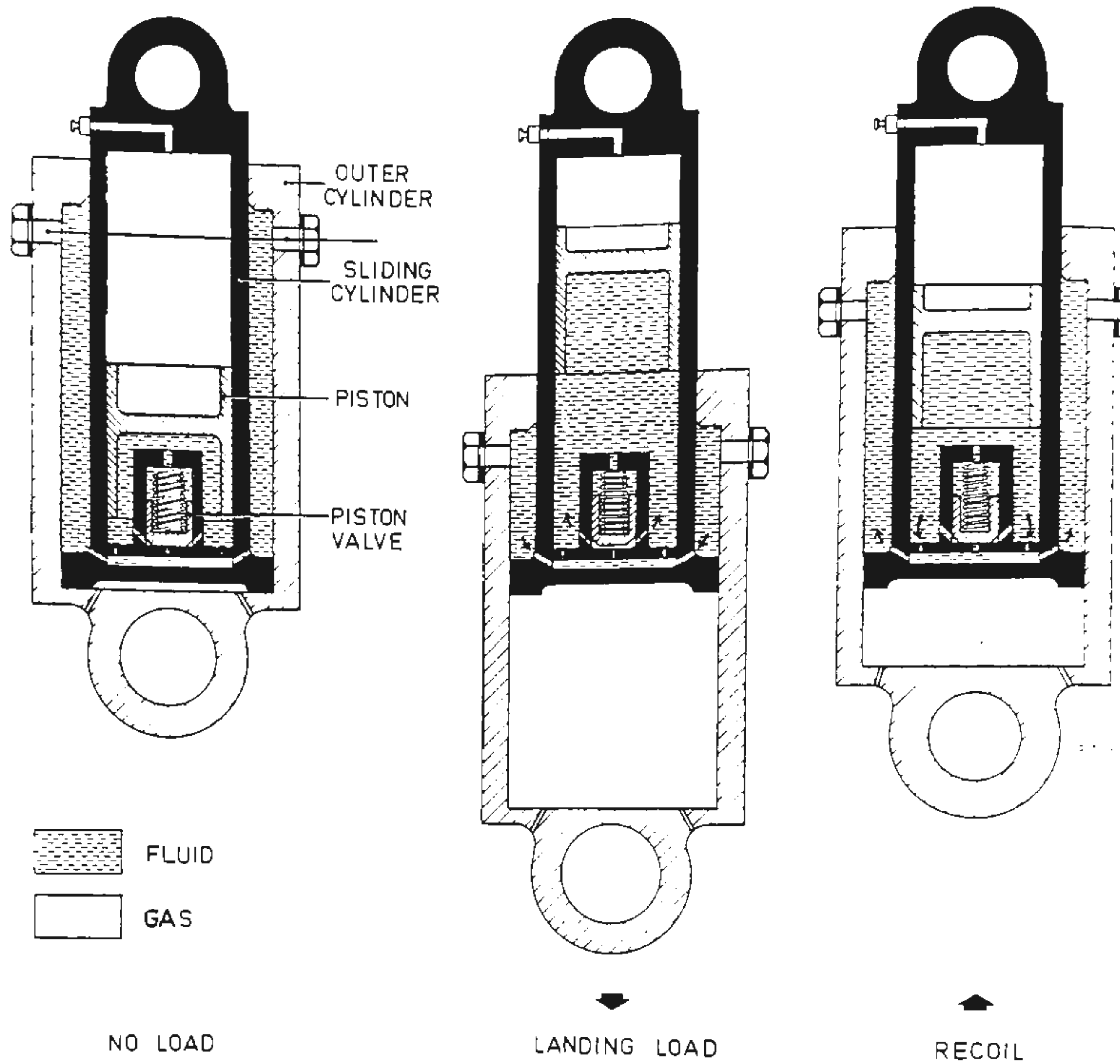
NOSE LANDING GEAR - UPLOCK UNIT



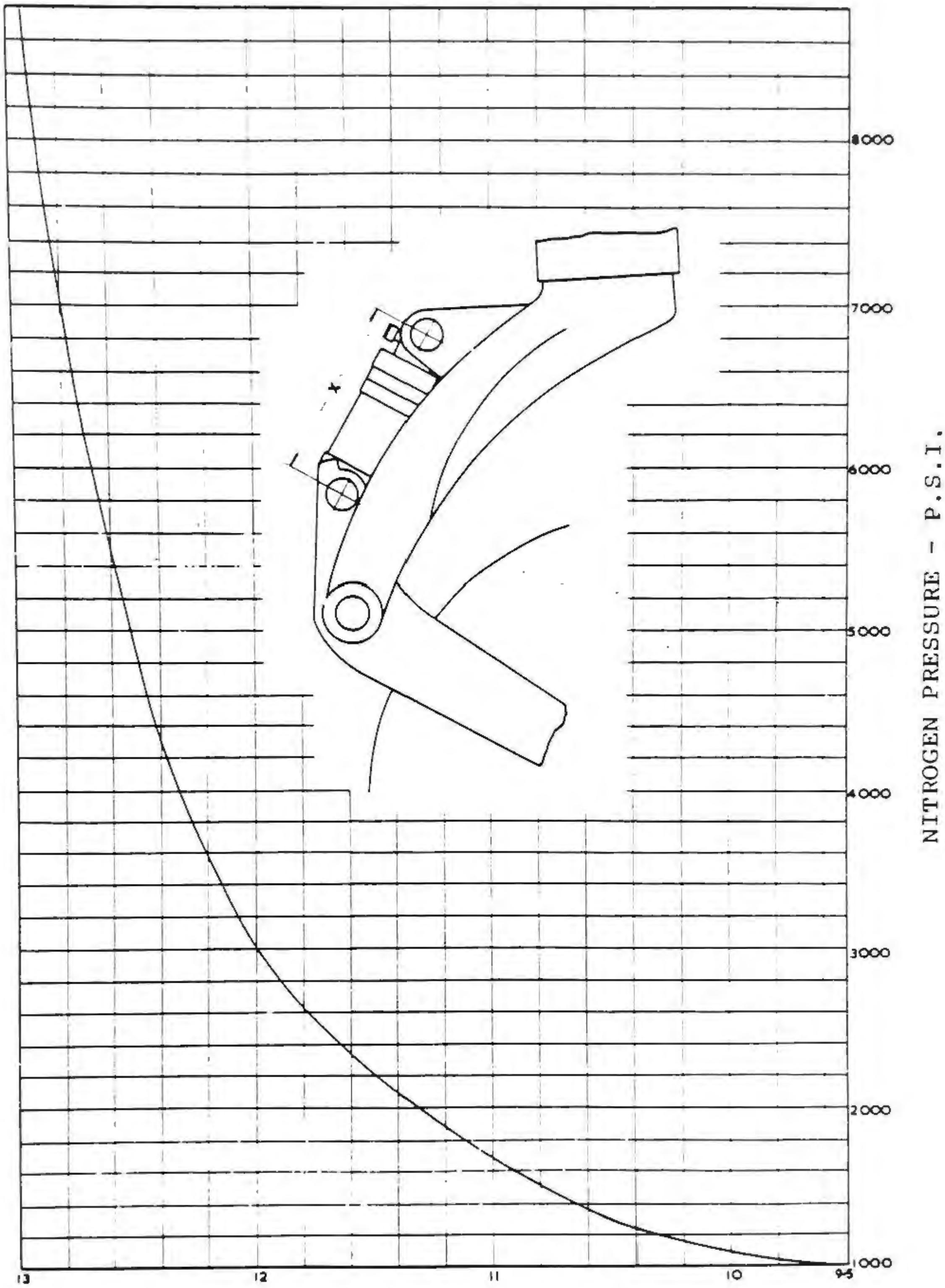
NOSE GEAR ACTUATING RAM



NOSE LANDING GEAR KINEMATICS AND DOOR KINEMATICS



NOSE GEAR SHOCK ABSORBER - PRINCIPLE OF OPERATION



NOSE GEAR SHOCK ABSORBER PRESSURE/EXTENSION GRAPH

21.0 GROUND LOCKS

Main Gear Ground Lock.

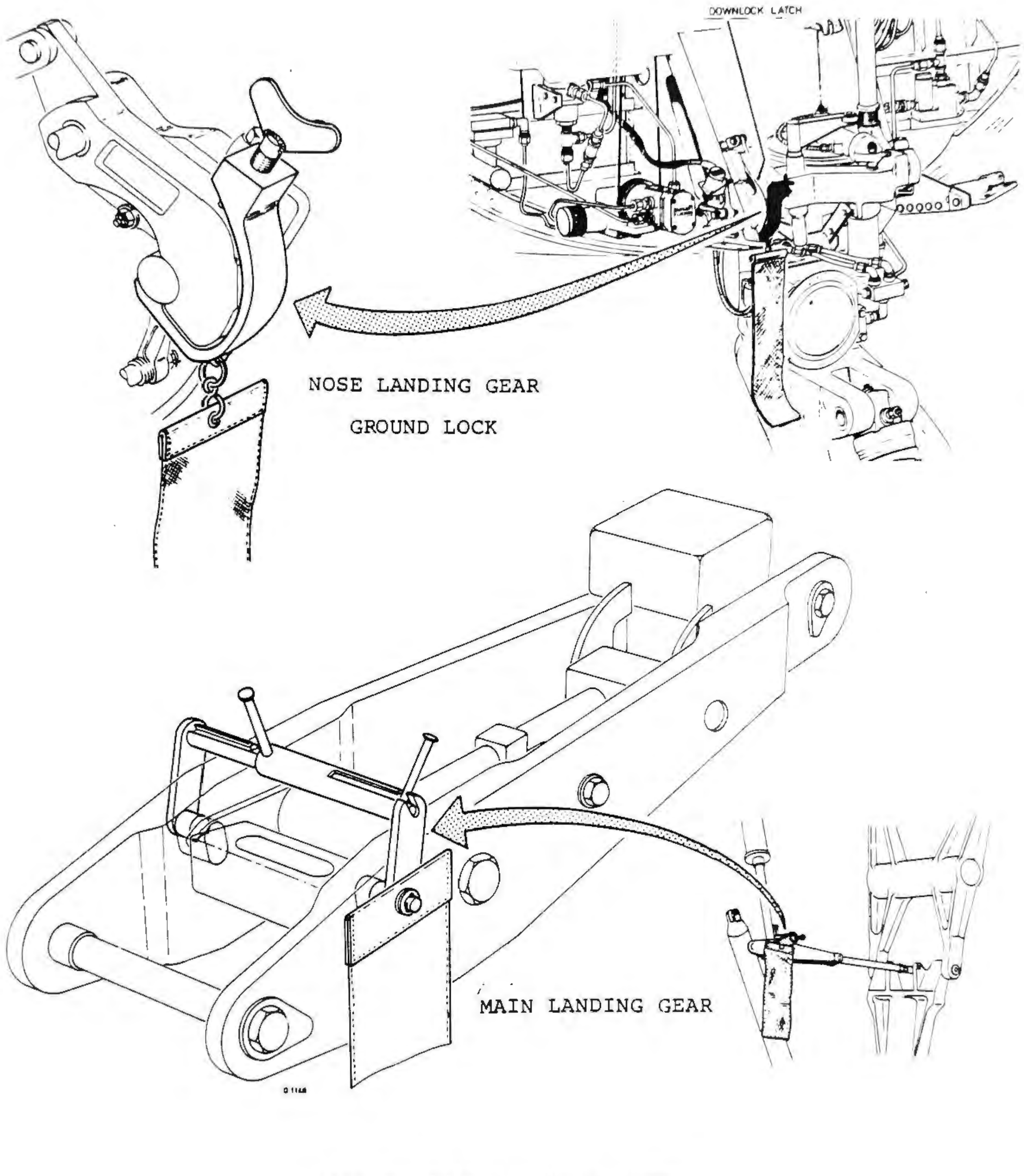
The main gear ground lock is designed to prevent the ram trunnion pins from moving upwards in their slots and thus to prevent the latch from moving out of the locked position. The lock fits over the forward arm of the lock strut, and spring-loaded pins are allowed to engage in the ram trunnion pin slots above the trunnion pins. A red streamer is attached to provide additional visual aid in ascertaining that the lock is installed.

CAUTION: BEFORE INSTALLING A GROUND LOCK, ENSURE THAT IT IS NOT DAMAGED OR DISTORTED. A DAMAGED OR DISTORTED GROUND LOCK MAY CAUSE DISENGAGEMENT OF THE LOCKING PINS. MALFUNCTIONING OF THE LANDING GEAR SELECTOR VALVE WILL THEN BE CAUSE TO INADVERTENT RETRACTION OF THE LANDING GEAR. WHEN SYSTEM TESTS ARE TO BE CARRIED OUT JACK THE AIRCRAFT ON MAIN AND NOSE JACKS BEFORE APPLYING UP PRESSURE.

Nose Gear Ground Lock.

The nose gear ground lock is designed to clamp over the downlock latch and the downlock pin of the nose gear to prevent withdrawal of the latch from the pin. The ground lock consists of a body clamped round the downlock pin and fixed by a pivot in the latch. The pivot is adjustable by a thumb bolt. A red streamer is attached to provide additional visual aid in ascertaining that the lock is installed.

END



LANDING GEAR - GROUND LOCKS

31.0 MECHANICAL CONTROL SYSTEM

This system can be divided in a:

a) Normal landing gear selecting system controlled by a control handle mounted on the main instrument panel.
b) Alternate landing gear selecting system controlled by a control handle located behind the pilot's seat.
   This system can only be used to unlock and extend the landing gear.

31.1 Control Handle

The landing gear control handle is mounted on a bracket on the forward pressure bulkhead and protrudes through a slot in the main instrument panel. The handle is provided with a knob which is locked against rotation by means of a spring-loaded locking pin. An overcentre spring holds the handle in the selected UP or DOWN position. With the aircraft on the ground UP selection is prevented by a ground safety lock assembly consisting of a locking lever, a locking pawl and an electrically operated solenoid. When the aircraft is airborne and the left-hand landing gear is fully extended, the LH ground/flight switch completes a circuit to the solenoid. The solenoid is energized to disengage the locking pawl from the locking lever, thus allowing the control handle, complete with locking lever, to be moved UP. When the solenoid fails to energize the control handle can be disengaged from the safety lock assembly by pulling the disengage trigger on the control handle knob and rotating the knob to either left or right until it is locked again after a rotation of approximately 60 degrees. The knob can be reset by loosening the knob attachment screw and sliding the knob from the handle far enough to rotate it back to its vertical position. After resetting, the attachment screw must be tightened fully.

31.2 Selector Valve

The landing gear selector valve mounted on the pneumatic panel comprises a valve assembly controlled by an eccentric shaft. With the landing gear control handle selected UP, the valve assembly is set in the up position causing the up lines to be pressurized and the down lines to be exhausted. When the shaft is moved to the down position the valve assembly is reversed to the down position causing the down lines to be pressurized and the up lines to be exhausted. The eccentric shaft lever is fitted with an overcentre spring which holds the valve assembly in the selected DOWN or UP position. The lever is connected to the sliding fork end of the teleflex control system by means of a pip pin. This allows quick disconnection of the shaft lever and manual operation of the valve in case of jamming of the teleflex system.

31.3 Lock Relay

This relay is installed in the main junction box. The relay is energized by the LH ground/flight switch when the landing gear is fully extended and in this condition completes a circuit to the lock solenoid. When the landing gear is retracted and locked, uplock microswitch no. II breaks the circuit to the relay thus de-energizing the relay and consequently the lock solenoid during flight. This will increase the service life of the lock solenoid.

31.4 Lock Solenoid

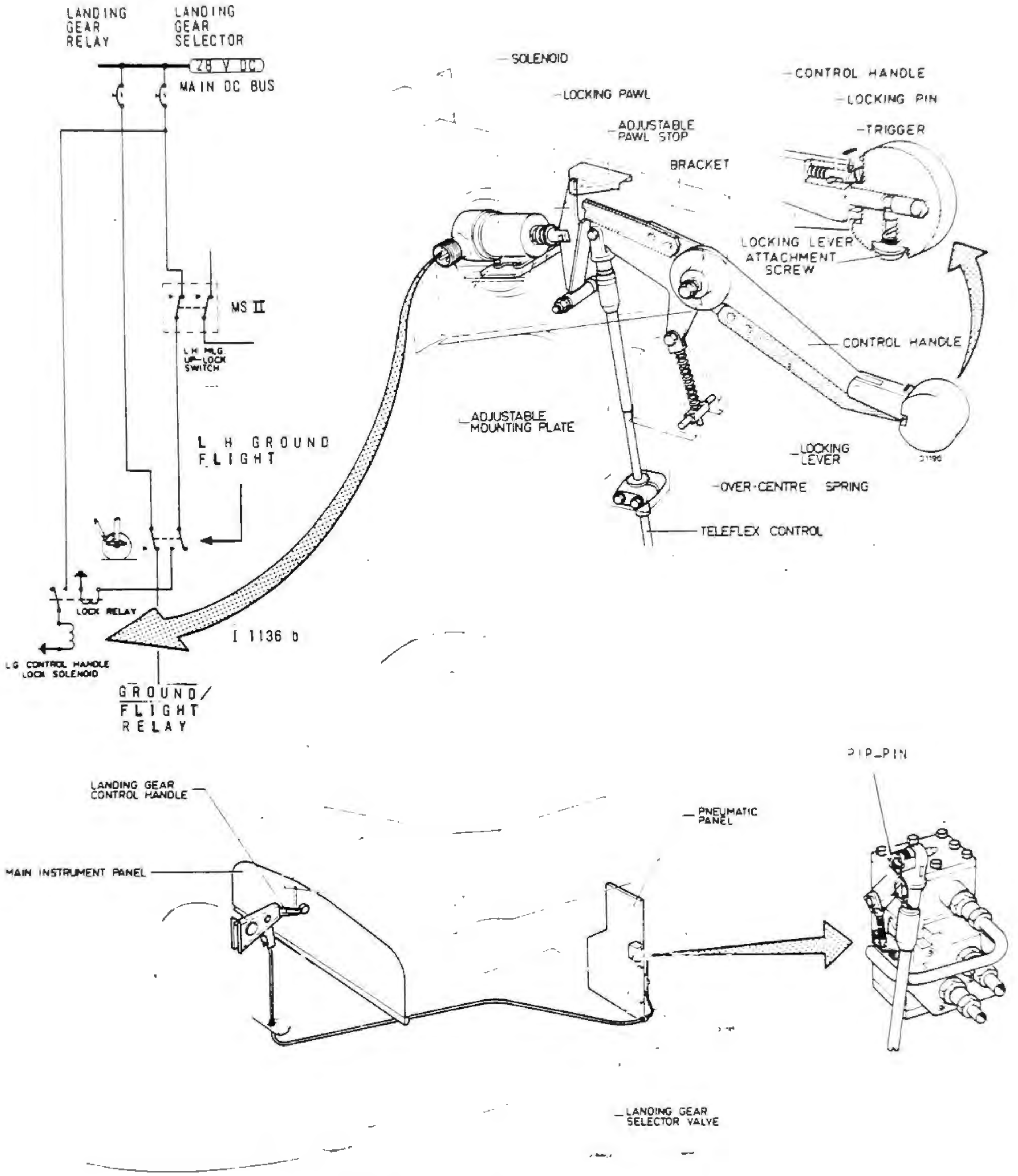
This pull type, continuous duty solenoid is secured to a mounting plate which in turn is bolted to the bracket at the pressure bulkhead. Longitudinal adjustment of the solenoid is provided by means of slotted holes in the bracket and serrated plates at the inboard attachment bolts.

The solenoid is connected to the locking pawl which locks the locking lever of the control handle when the solenoid is de-energized and the handle is in the DOWN position. When energized the solenoid withdraws the pawl thus allowing the control handle to be moved up.

31.5 Alternate Control Mechanism

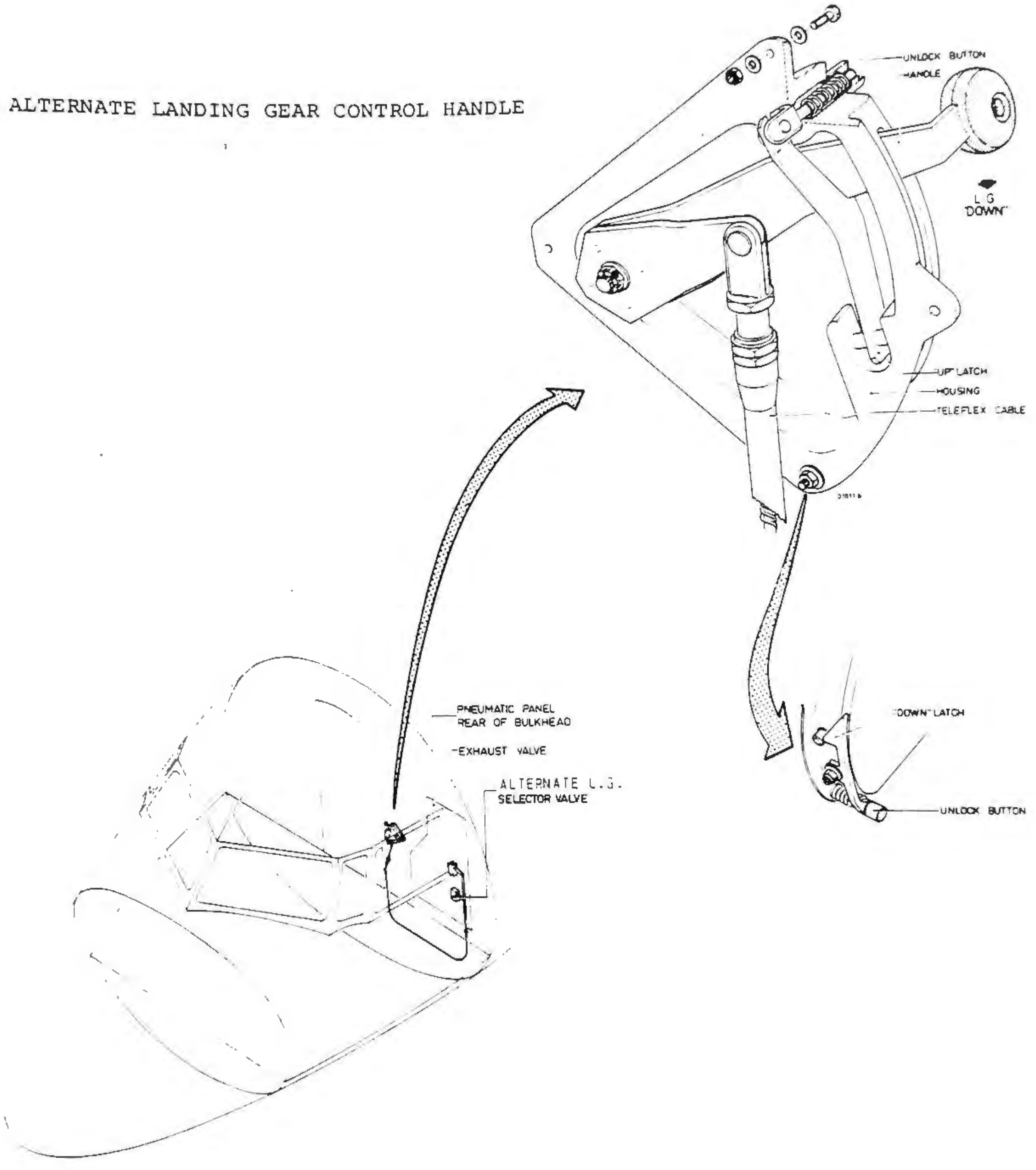
The alternate control mechanism is mounted on the cockpit wall behind the pilot's seat. It is locked in the UP and DOWN position by a spring-loaded latch. The latch unlock button is to be pressed to allow the handle to be moved. A teleflex cable connects the assembly to a lever on the alternate selector valve, which is mechanically interconnected with the exhaust valve, that is installed in the landing gear up line.

END



NORMAL LANDING GEAR CONTROL

ALTERNATE LANDING GEAR CONTROL HANDLE



ALTERNATE LANDING GEAR CONTROL

33.0 LANDING GEAR PNEUMATIC SYSTEM

The landing gear pneumatic system consists of a normal system and an alternate system.
The normal system is supplied with pneumatic pressure from the main storage bottle while the alternate system is supplied with pneumatic pressure from the alternate storage bottle.
With the gear selected UP, the landing gear selector valve directs pneumatic pressure, reduced from storage pressure to 1000 psi directly into the upside of the gear actuating rams. Initial movement of the actuating ram pistons unlocks the downlocks of main and nose gear to allow retraction of the gears. When fully retracted, the gears are locked by uplock assemblies, locked to the closed position by spring-loaded uplock rams. If the landing gear is selected DOWN, the landing gear selector valve directs the 1000 psi pressure which is further reduced to 100 psi to the down side of the gear actuating rams and the uplock rams. The uplock rams unlock the uplock units to allow extension of the landing gear. A non-return valve is installed in a line bypassing the 100 psi reducing valve to enable rapid exhaust of the down lines during retraction.
A discharge valve is connected to the down lines to enable discharging of the pneumatic pressure in these lines.
When the alternate control handle is operated, pneumatic pressure from the alternate storage bottle, first reduced to 1000 psi and then to 100 psi is allowed to enter the alternate down lines while the pressure in the up lines is simultaneously exhausted to atmosphere through the exhaust valve which is mechanically interconnected to the alternate selector valve.
Shuttle valves, incorporated in the gear actuating rams and the uplock rams shut off the system not in use.

33.1 Landing Gear Selector Valve

See sub-chapter 31.0

33.2 Pressure Reducing Valves (Normal System)

Air supply from the main storage bottle is reduced by a reducing valve (1000 psi) installed upstream of the landing gear selector valve and mounted on the pneumatic panel. A second reducing valve (100 psi) is installed in the landing gear down line and also mounted on the pneumatic panel. A relief valve is incorporated in the valve housing at the reduced pressure side to relieve excessive pressure due to malfunctioning of the valve or excessive temperature rise.

33.3 Non-Return Valve

A poppet-type non-return valve is installed in the bypass line over the low pressure reducing valve to allow trapped air in the down lines to exhaust through the selector valve during retraction. The valve is mounted on the pneumatic panel.

33.4 Discharging Valve

This valve, screwed into a manifold of the down line on top of the pneumatic panel, serves to release the down pressure when required during maintenance. To release the pressure remove the cap with nipple plug and depress the spring-loaded valve core.

33.5 Main and Nose Gear Actuating Ram
See sub-chapters 10.0 and 20.0

33.6 Main and Nose Gear Up-lock Assembly
See sub-chapters 10.0 and 20.0

33.7 Uplock Rams

The main and nose gear uplock rams are attached to their respective uplock assemblies. The rams are spring-loaded to the locked position and connected to the down lines to be actuated during gear extension.
A shuttle valve is incorporated in the inlet ports so that both the normal and emergency extension systems can be used to actuate the uplocks.

33.8 Alternate Selector Valve

This two-position, manually operated, selector valve is mounted on the pneumatic panel. In the ON position air supply is directed to the actuating rams; in the OFF position the supply is cut off and the pressure in the rams is released through the exhaust port. The operating lever is held in its extreme positions by the throwover action of external springs.

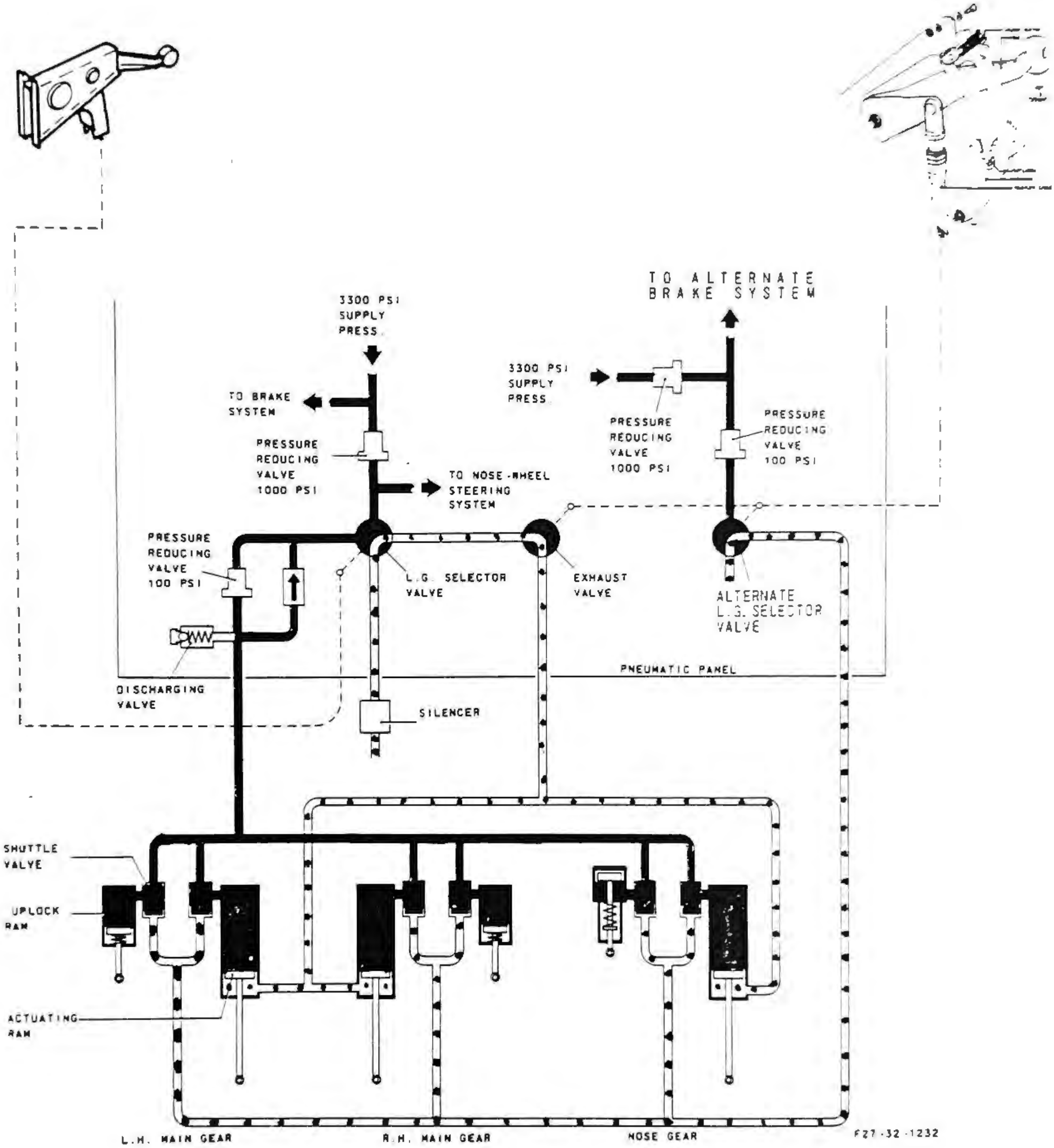
33.9 Exhaust Valve

This two-position, manually operated valve is mounted in the pneumatic panel. When the alternate selector valve is operated, the exhaust valve fitted in the landing gear up line allows the pressure in the up line to be exhausted through its top port.

33.10 Pressure Reducing Valves Alternate System

Air supply from the alternate storage bottle is reduced by a reducing valve (1000 psi) mounted on the pneumatic panel. For the alternate down system of the landing gear the air supply is reduced in a second reducing valve (100 psi) installed upstream of the alternate selector valve and mounted on the pneumatic panel. A relief valve is incorporated in the valve housing at the reducing pressure side as a safety feature.

END



DOWN

LANDING GEAR CONTROL - PNEUMATIC SYSTEM

34.0 GROUND HANDLING AFTER ALTERNATE OPERATION

If the alternate control system has been operated before landing, the following instructions must be strictly observed in order to prevent serious damage of the aircraft due to inadvertent retraction of the landing gear when the alternate landing gear control handle is reset to the normal position.

WARNING: NEVER RESET THE ALTERNATE LANDING GEAR CONTROL HANDLE TO NORMAL POSITION BEFORE THE GROUND SAFETY LOCKS HAVE BEEN FITTED AND THE ISOLATING VALVES HAVE BEEN CLOSED.

Immediately after landing fit the ground safety locks.
Close the isolating valves.
Jack the aircraft.
Reset the alternate landing gear control handle to the normal position.
After repair perform functional test and fit ground safety locks before lowering the aircraft from the jacks.

END

35.0 LANDING GEAR RETRACTION TEST

CAUTION: This information is not complete and to be used for training only. For actual retraction tests always refer to the Maintenance Manual.

This test has to be carried out:

. periodically
. when any components in the landing gear system are replaced or readjusted.

Preparation:

. Disconnect the main and nose gear doors.
. Disconnect the operating rod from the isolating valves, close the main storage bottle isolating valve, open the system isolating valve.
. Connect a ground charging unit to the ground charging connection in one of the nacelles and pressurize the system to 3300 psi.

Clearance check:

. Retract gear and check clearance between piping, cables and structure.
. Extend gear, connect the main and nose gear doors.
. Operate gear once more and check that doors are flush.

Position indication check:

. Gears down and locked - three green lights.
. Gears in transit - three red lights.
. Gears up and locked - no lights.

Warning system check:

. With the gear not down and locked, close the throttles. Warning horn shall sound.
. Push silencer button. Warning horn shall stop.
. Select flaps down with the gear up.
. Warning shall sound when flaps travel through 26.5°.

Uplock check:

. With the landing gear up close the system isolating valve and release the system pressure.
. The red lights shall remain out. This means that the uplock units are locked properly and that the microswitches are adjusted properly.
. Open the isolating valve and extend the gear.

Retraction and extension time test:

This is to check the gear operating time required to retract the gear until up and locked, and the operating time required to extend the gear until down and locked. The retraction time must be adhered to in view of the take-off performance.

Nose gear downlock test:

Special attention is required for the positive locking action of the nose gear downlock mechanism. With the gear extended use a spanner to lift and release the latch. Check that the latch engages smoothly.

Alternate Extension Test:

This test is carried out to ensure that the landing gear can be unlocked, extended, and locked when an alternate down selection is made. The extension time should be recorded. Also checked is the minimum required pressure to unlock the retracted gears. After this test the alternate extension lever should be returned to normal and the gear recycled on the normal system.

END

40.0 WHEELS AND BRAKES

40.1 Main Wheels

Each main landing gear is equipped with dual wheels which are designed to accommodate brake discs and Maxaret antiskid unit. The wheel may be of the loose flange type or of the divided type. Several type variants are in use. The inner periphery of the hub is machined to form a tire track for use in conjunction with a Maxaret antiskid unit and is also formed with a series of lugs which are fitted with drive blocks secured by rivets or a screw.

A Schrader type valve assembly is secured in the tire seat area. When the wheel is to be used with a tire and tube, the valve assembly is removed and the hole in the tire seat area used for the integral valve stem of the tube.

The wheel hub houses two bearings, grease seals and retainers. A collar and retaining nut secures the wheel to the axle.

40.2 Nose Wheel

The nose gear is equipped with a split type wheel of which several type variants are in use. Basically they are the same as the one described below but differ in respect of the form of the hub construction. The wheel consists basically of two half hub assemblies which are secured together by bolts, nuts and washers. A rubber C-ring is sandwiched between the rim portion of the half hubs. Each half hub houses a tapered roller bearing, a grease seal and a split locking ring.
The wheel is designed to be used with either a conventional tire and tube or with a tubeless tire. Normally the wheel is delivered with a Schrader type inflation valve, secured in the tire seat area. When the wheel is to be used with a tire and tube, the valve assembly is to be removed and the hole in the tire seat area used for the integral valve stem of the tube.

40.3 Brake Units

A twin rotor brake unit (Dunlop) is fitted on each main wheel.
Although the brake units are fully interchangeable between the four wheels, there are differences in installation between inboard and outboard wheels.

A torque plate is the basic part of the twin rotor brake on which the other parts are assembled. The plate, bolted to the stationary integral flange of the main gear axle, is provided with eight brake cylinders, interconnected with each other and with a shuttle valve on top of the brake unit by internal drillings. Three stator plates, keyed to the torque plate and provided with friction pads and two rotors keyed to the wheel form the braking surfaces. Application of either normal or alternate pneumatic pressure, forces the outer stator plate inward to entrap the rotating segmented rotors between the stator plates. The pressure plate is spring-loaded to return to neutral when pressure is released.

Brake Pad and Disc Wear.

As full pad wear takes place in two stages, the event of maximum wear at each stage will present different servicing procedures. The progress of pad wear may be determined by measuring the depth from the outer face of the return spring housing to the outer face of the spring top plate with the brake pressurized. Check each housing in turn in this manner. If any measurement reaches too high a value or if the pad wear gauge face contacts the outer face of the spring housing, the following operations must be carried out:

If the adjustable thrust plate is in its first stage position (i.e., with mortises and tenons engaged with thrust ring assembly) the thrust plate must be revolved so that its tenons abut the tenons of the thrust ring assembly, thus providing a further period of service life. At this stage provision may be made for wear additional to that described by fitting a shim between the pressure plate and the adjacent stator plate. Adjust the thrust plate in the following manner:

With the brake unpressurized unlock and remove the two bolts securing the adjustable thrust plate to the thrust ring assembly.
Disengage the thrust plate from the thrust ring and rotate it through 15 degrees, so that the tenons on each component are abutting and two new threaded holes are in alignment with the holes in the thrust ring assembly.
Fit the bolts and lock them.

If the adjustable thrust plate is in its second stage position, the complete set of rotor and stator assemblies must be replaced by reclaimed or new assemblies.

40.4 Brake Systems

Two separate systems, one for normal and one for alternate operation, are installed on the aircraft. The normal system obtains its pressure direct from the normal supply system via a non-return valve, and a pressure reducing valve while the alternate system obtains its pressure from the alternate bottle via a pressure reducing valve.

The normal system consists of a bottle, pressure gauge, relief valve and a left-hand and right-hand gear control system. Each gear system consists of a brake valve, a rapid exhaust valve, pressure gauge, two anti-skid units and two brake assemblies.

The brake control valves are operated by either the pilot's or copilot's brake pedals through mechanical linkages. A handle connected by a teleflex cable to levers beneath each brake valve provides means of applying the parking brakes.

The alternate brake system consists of a selector valve installed in the LH side panel and an adjustable restrictor, which prevents sudden application of the brakes. The selector valve directs the pressure from the alternate pneumatic system directly to the brake assemblies on the wheels.

40.5 Pressure Reducing Valve

This valve is installed between the pneumatic panel and reduces the brake pressure for the normal brake system to 1000 psi.

40.6 Brake Operating Mechanism

Two horizontal torque tubes are connected to the brake pedals by adjustable rods. The pilot's and copilot's right-hand pedals are connected to one tube while the LH pedals are connected to the other. Each torque tube itself is connected to a brake control valve. Return springs installed on the torque tube actuating levers ensure full release of the brake control valves. Overloading is prevented by stop bolts on the LH and RH side.

40.7 Brake Control Valves

Two brake control valves, one for the brake units on the LH main gear and one for the brake units on the RH main gear are attached to the front pressure bulkhead in the cockpit. The attachment holes in the mounting

bracket side plates are elongated to allow for vertical adjustment of the valves. This adjustment is accomplished by means of a special bolt.

The valve is spring-loaded to the off position and is operated by the brake mechanism, or the parking brake. The valve has a metering action and the pressure to the brakes depends upon the force exerted at the pedals. When the valve returns to the off position the air trapped in the pneumatic lines is exhausted through the exhaust port.

40.8 Parking Brake System

A parking brake handle is located on the front panel at the LH side of the cockpit and connected to locking levers underneath the brake control valves. A teleflex cable connects the handle to the leverage under the LH brake control valve.

The two parking brake mechanisms at the brake control valves are coupled by a push-pull rod. A coil spring is attached to release the mechanism when the parking brake handle is unlocked. The handle is locked by a ratchet teeth and engage mechanism.

For parking simply pull handle.

To release the brakes:

1) Turn handle counterclockwise.
2) Release.

The parking brake can be adjusted by a bolt on the actuating levers.

40.9 Rapid Exhaust Valves

A rapid exhaust valve is installed in both the right-hand and left-hand brake lines to allow rapid exhausting of the air in the brake assemblies when the brake control valves are released. The valves are clamped to an angle piece at the wing lower skin in front of each nacelle bulkhead.

40.10 Brake Operation

Before the application of brakes, all the lines downstream of the brake control valve contain normal atmospheric pressure. Movement of the captain's or co-pilot's pedals operates the brake control valve through a mechanical linkage. Depressing the left-hand pedals directs air through the left-hand control valve to the rapid exhaust valve in the-left hand nacelle, and depressing the right-hand pedals directs air to the rapid exhaust valve in the right-hand nacelle.

Each brake control valve has a metering valve, operated by the pedals. The pressure applied to the brakes is in proportion to pedal application with a maximum of 1000 psi.

Upon application of air to the rapid exhaust valve, the exhaust port of the valve closes and when sufficient pressure is built up the inlet port opens and the air supply then passes through the rapid exhaust valve to the Maxaret anti-skid units. The air enters, via the Maxarets, the brake units through shuttle valves mounted at the brake inlet ports. When the brakes are released a part of the air is exhausted via the brake control valve which gives a pressure drop in the brake line. A small decrease in pressure allows the exhaust port of the rapid exhaust valve to open to atmosphere, and all the pressure to the brakes is exhausted in the nacelle to give a quick and

immediate release of the brakes. When pressure is released the pressure plate and piston on the brake units are returned by the eight spring units.

The Maxaret anti-skid unit is designed to permit maximum brake application without any hazard of a wheel skid.

Upon fast wheel deceleration a flywheel in the unit operates a valve system to release the pressure in the brake unit. Consequent reduction in brake torque allows the wheel to regain speed, and the valve system returns to normal.

40.11 Anti-skid Units

The Maxaret anti-skid unit is designed to permit maximum braking without skidding of the wheel. The unit is installed on the inner side of each main wheel assembly and interposed in the normal brake supply line. It automatically releases brake pressure in the brake assembly when the wheel attempts to skid.

The unit consists of a valve assembly coupled to a control assembly. The control assembly consists of a flywheel, a drum and a drive assembly driven by the main wheel and comprising a detachable shell provided with a rubber tire, drive ring and main spring. The tendency of the main spring to expand imparts a drive to the drum. In this condition thrust balls lie in the apex of the drum's cam profile and a spring-loaded thrust rod holds the inlet valve open. Pressure from the brake control valve is thus transmitted freely to the brake assembly.

When the main wheel and consequently the drive assembly decelerates suddenly the flywheel overruns the drum.

The overrun is limited to 60 degrees by segmental bosses after which the flywheel drives the drum, thereby collapsing the drive spring, and thus relaxing the normal contact. The relative motion between flywheel and drum causes the thrust balls to ride up the cam profile, thereby operating the valve assembly. The inlet valve is closed and the exhaust valve opened reducing the pressure at the brake unit.

Spring load forces the rubber tire on the main wheel drive track. The anti-sk units are handed and identified as R.A.P. (right-hand anti-clockwise rotation pneumatic) and L.C.P. (left-hand clockwise rotation pneumatic).

Periodically check the shell for excessive axial clearance between its bearing mounting points. The tire should be undamaged and in correct engagement with the rim of the main wheel. The spring-loading should be sufficient for resistance to be felt if the Maxaret shell is turned by hand and to produce a flat at the Maxaret tire contact point with the driving track of the landing gear wheel of not less than 0.5-inch (12.5 mm). Check the progress of Maxaret tire wear. The limit of wear is reached when the tire is worn down to, but not beyond, the wear indicating rib molded on the tire side wall.

Servicing of the Maxaret units consists of carrying out a functional check, inspecting the Maxaret tire for condition, and the exhaust valve port for obstructions.

The functional check on the Maxaret units may be performed as follows:

a. Parking brakes off

Move the Maxaret unit out of contact with the drive track on the main wheel and spin the Maxaret unit wheel in the direction indicated on the

data plate. Suddenly stop the rotation of the Maxaret unit wheel and a loud click should be heard.

b. Parking brakes on

Carry out the same procedure as mentioned under "a", but instead of a click the hissing sound of air, released from the brake unit through the Maxaret unit, should be heard.

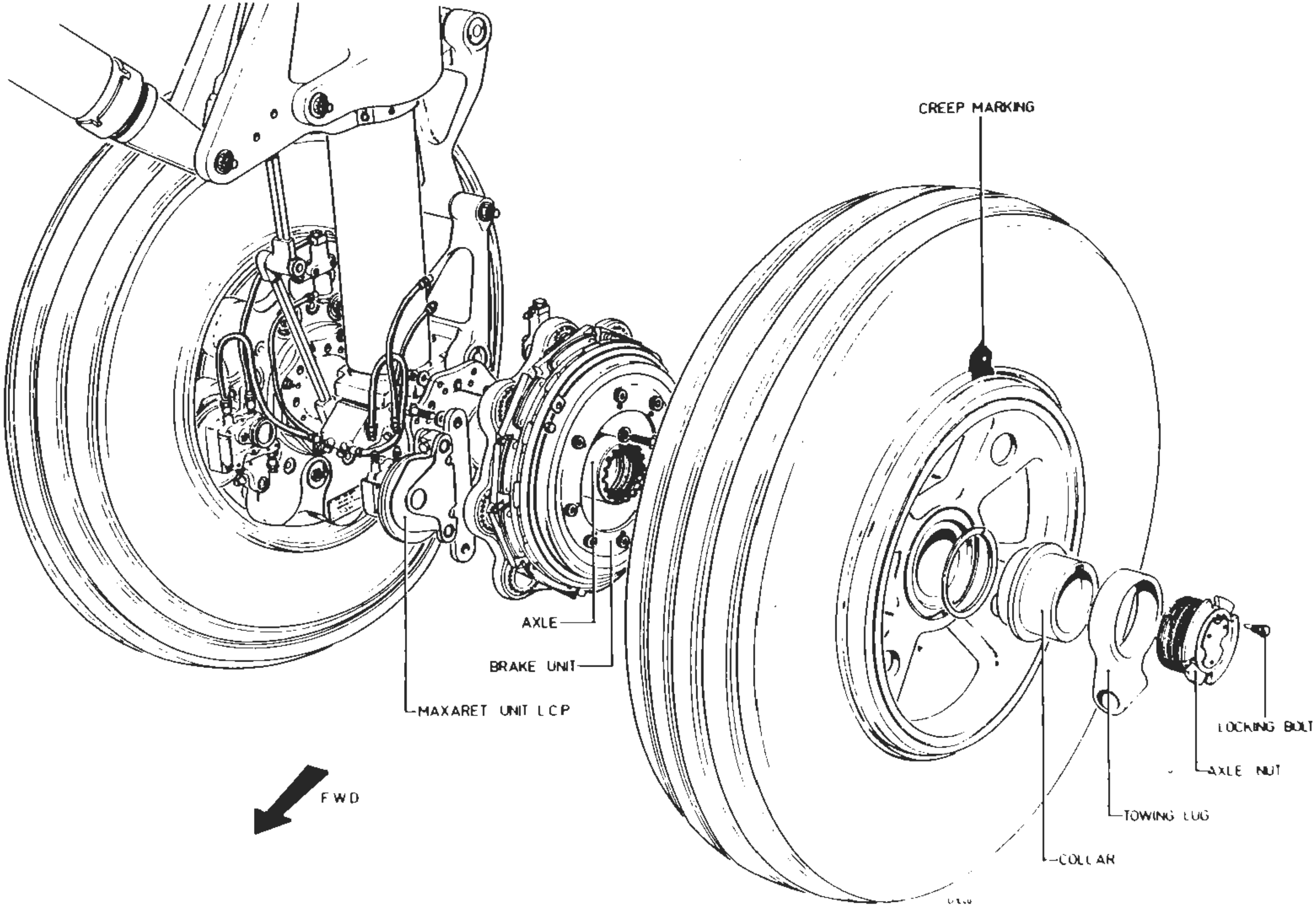
The procedure mentioned under "b" is the most effective one to check the serviceability of each Maxaret unit.

40.12 Alternate Brake System

The alternate system is independent of the normal brake system having its own air supply from the alternate brake storage bottle.
This pressure is reduced to 1000 psi and directed via an adjustable restrictor to the alternate brake selector valve mounted on the pneumatic panel.

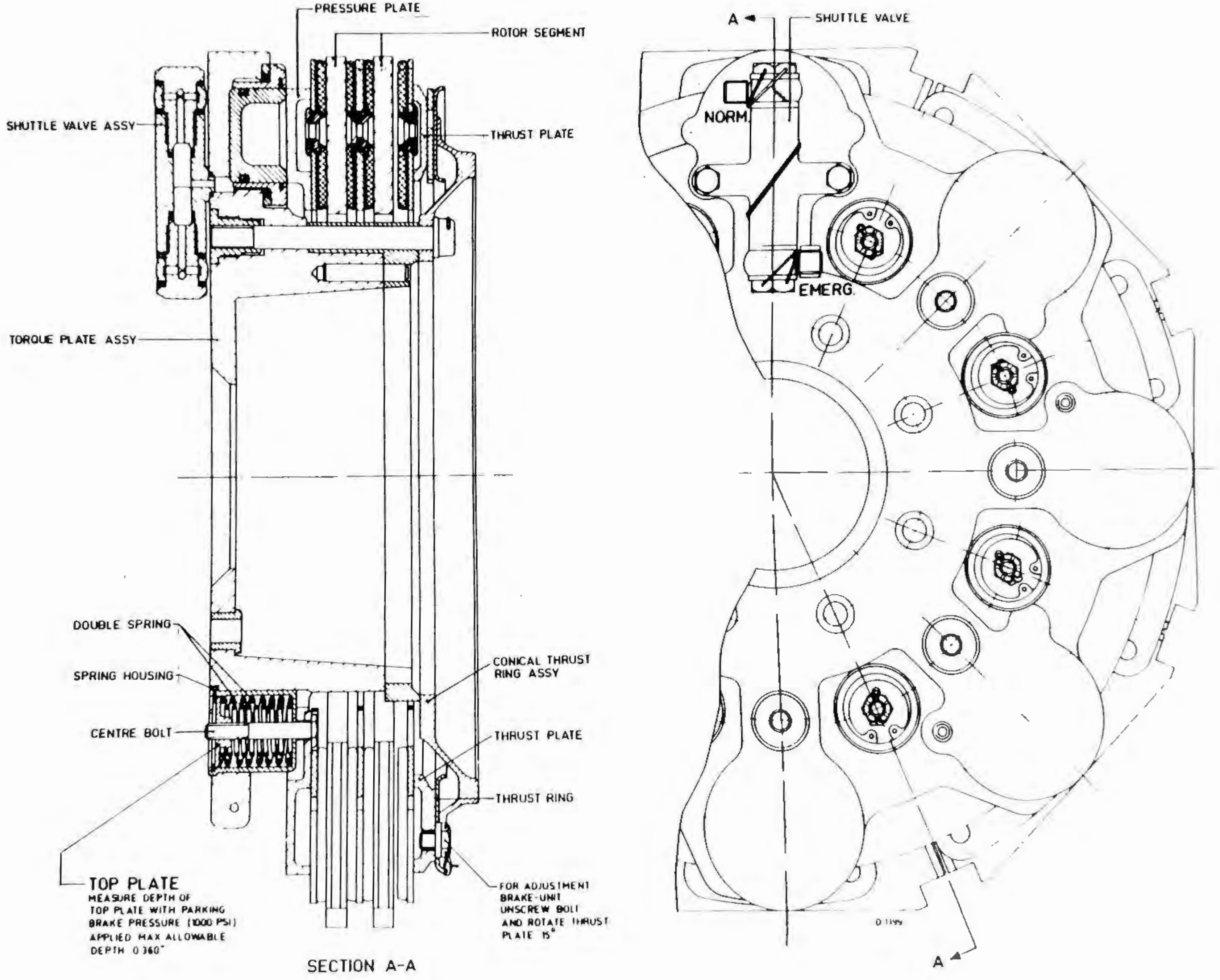
This valve is controlled by a three-position knob OFF - HOLD - ON on the LH side panel.
OFF means that the brake lines are vented.
ON means that the pressure can pass to the brake units which means that all four brake units receive the same pressure so no differential braking is possible. The pressure built up to 1000 psi to the brake units will be delayed by the adjustable restrictor (4 sec.).
HOLD means that when the knob is turned from ON to HOLD the applied pressure to the brakes is trapped.
Since the brake pressure is directly routed to the brake units no anti-skid is available when using the alternate brake system. The pressure stored in the alternate brake bottle is indicated in the cockpit.

END

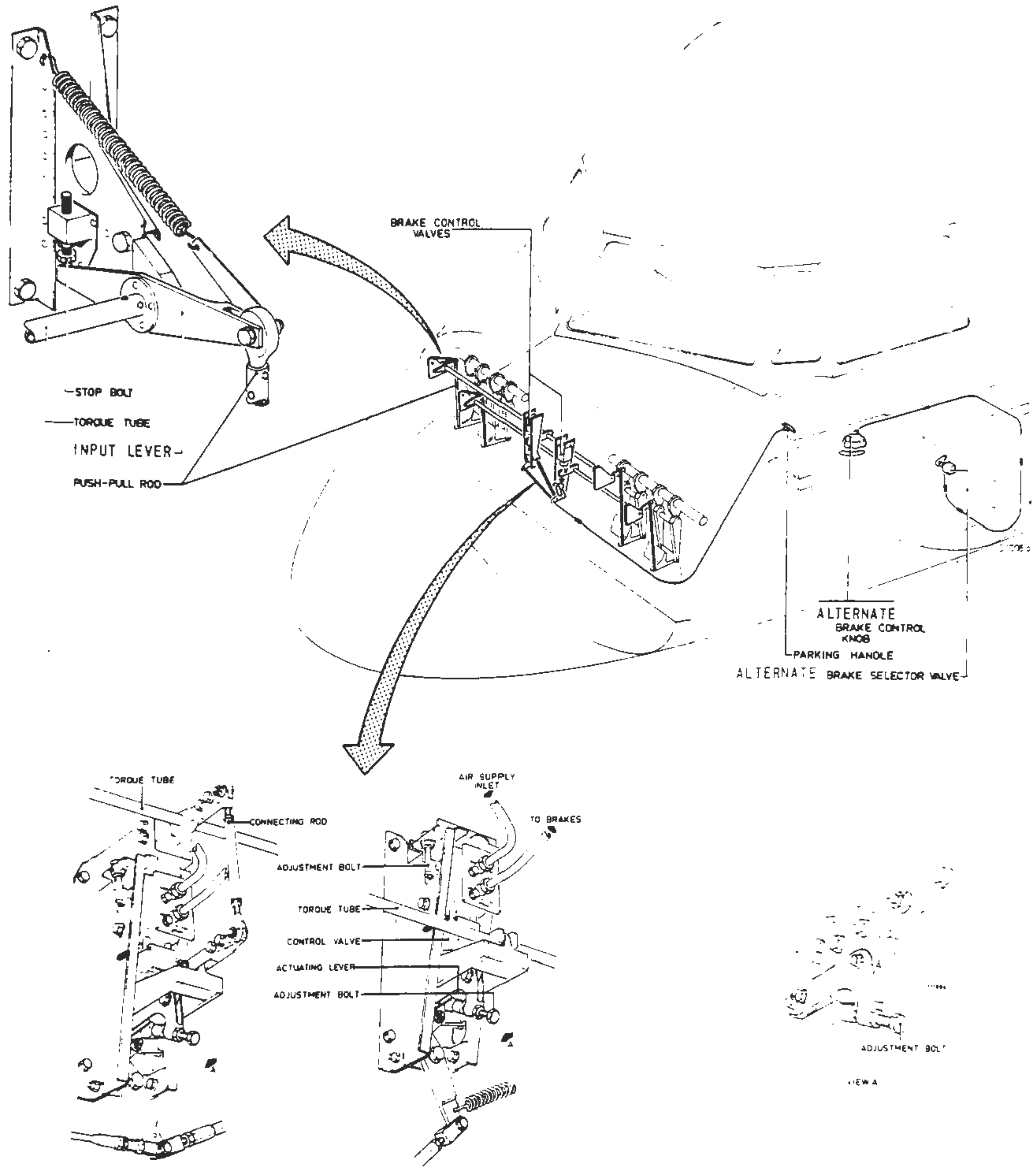


TYPICAL INSTALLATION OF MAIN WHEELS, MAXARETS & BRAKE UNITS

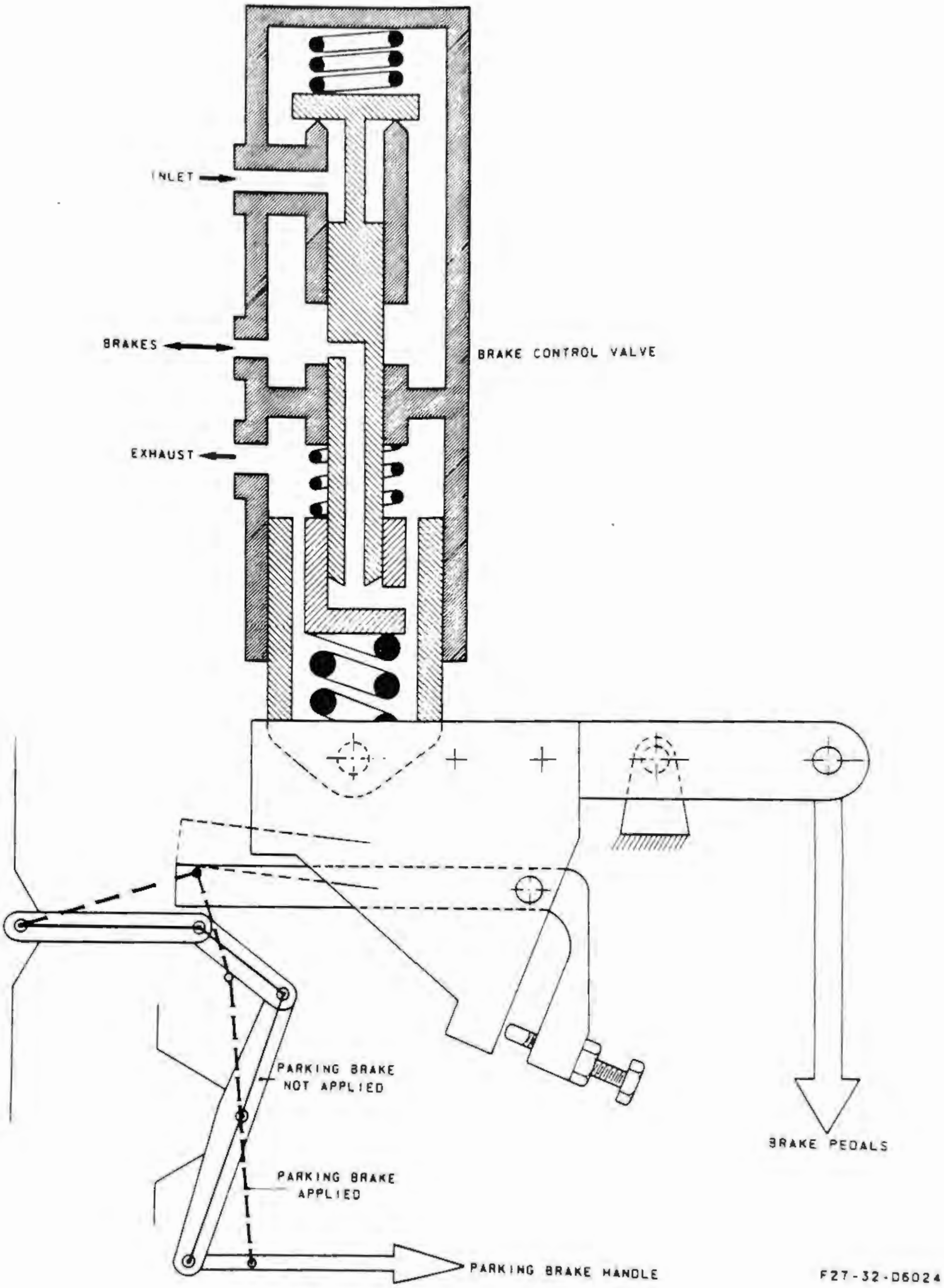
32.40
Fig.2



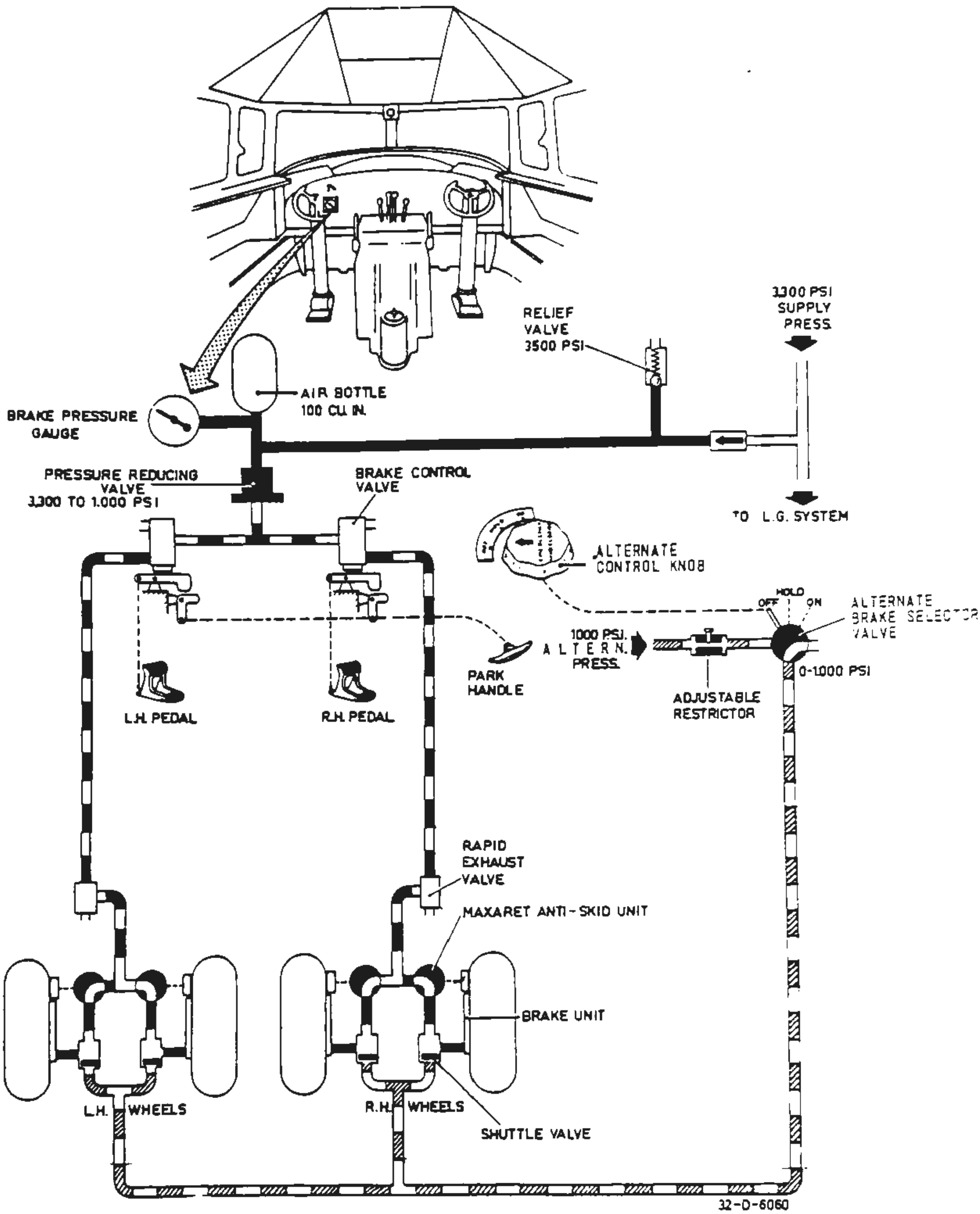
TWIN ROTOR BRAKE UNIT



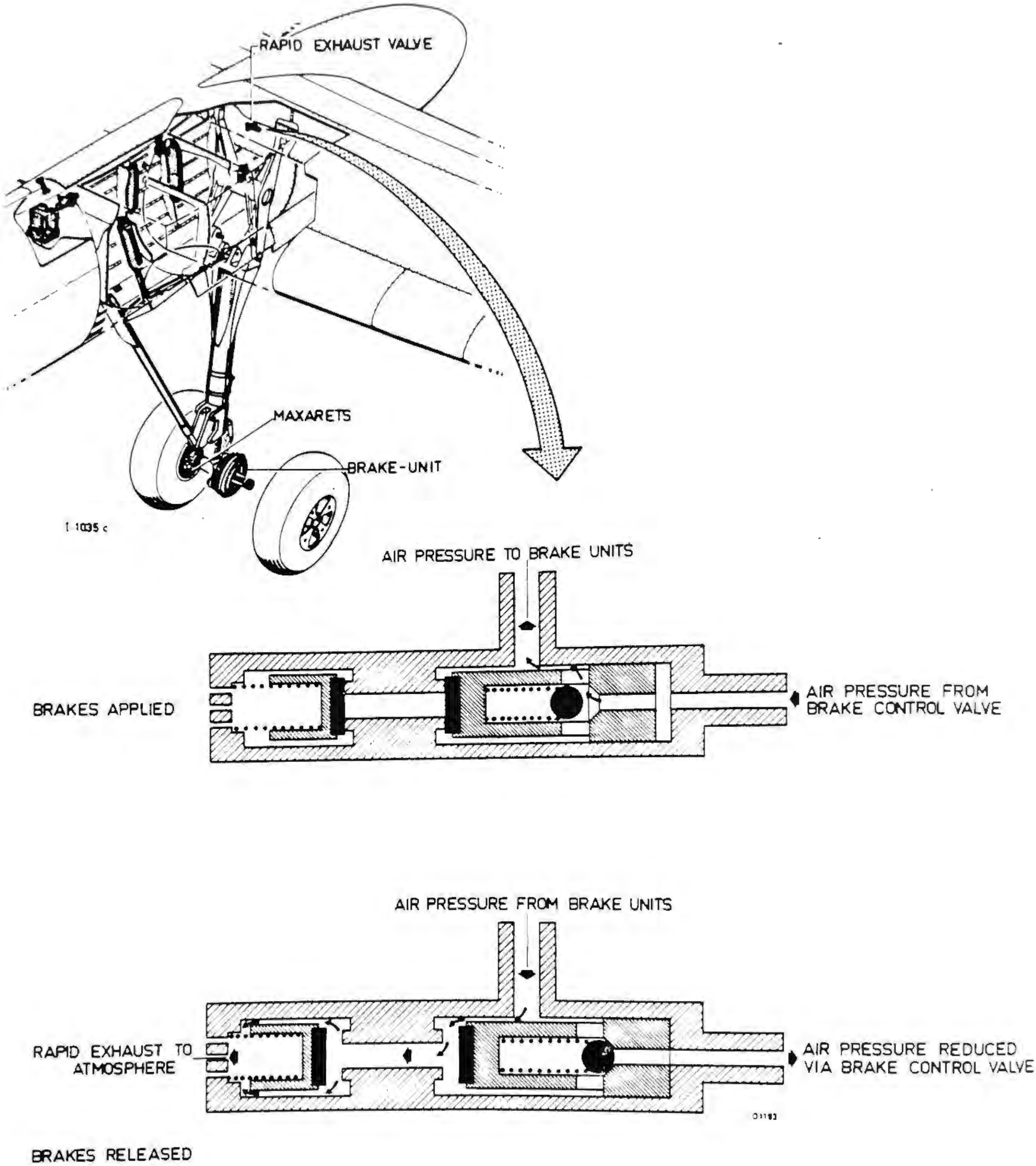
BRAKE CONTROL MECHANISM



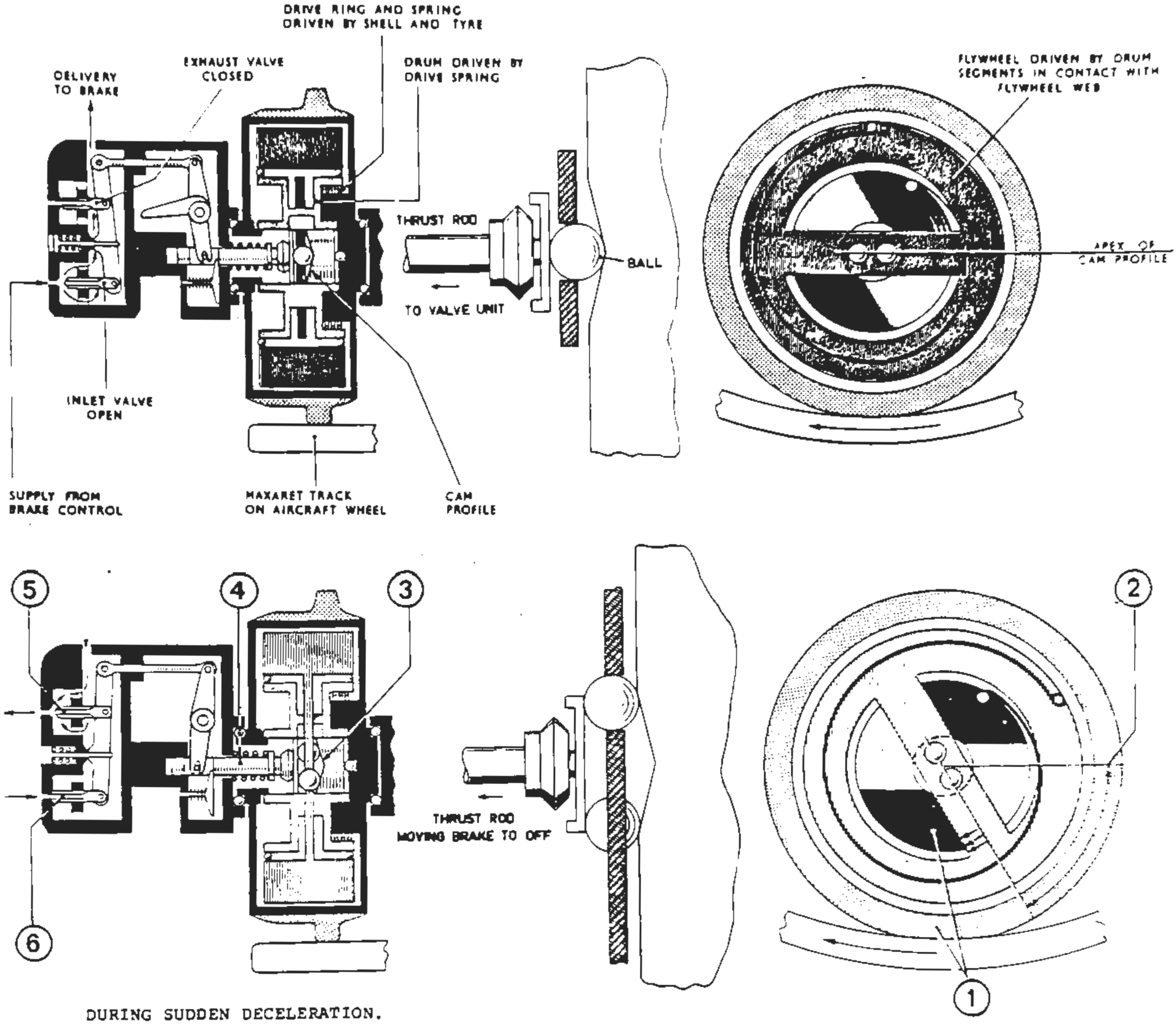
BRAKE CONTROL VALVE AND PARKING BRAKE MECHANISM (SIMPLIFIED)



WHEEL BRAKE SYSTEM



RAPID EXHAUST VALVE - SCHEMATIC DIAGRAM



DURING SUDDEN DECELERATION.

1. Deceleration of the shell and drum is increased beyond the datum setting of the flyweel and main spring.
2. The inertia of the flyweel causes it to be displaced relative to the drum by 60 degrees in the direction of rotation, against the action of main spring.
3. Movement of flyweel relative to drum causes the thrust balls to ride up the cam profile and,
4. move the thrust rod to actuate the valve operating linkage.
5. The exhaust valve opens and reduces the operating pressure in the brake unit as.
6. The inlet valve closes and isolates the operating pressure supply.
7. As the result of the reduction in brake operating pressure,the weel regains the datum velocity. The flyweel and the drum then resume their original relative positions under the action of the main spring. The valve assembly is moved to the neutral position. The effect of the Maxaret unit is smoothed by the natural time lag between its actuating and the response of the brake unit.

ANTISKID UNIT - FUNCTIONAL DIAGRAM

41.0 TESTING OF THE BRAKE SYSTEMS

A test plug on the Maxaret units can be used to connect a pressure gauge. With this indicator the actual brake pressure can be checked. Adjustments can be made by adjustment bolts on the input system. The parking brake can be adjusted by a special bolt on the input bracket just below the brake control valve.
Check also that the pressure difference between the left-hand and right-hand brake units does not exceed a certain value (see maintenance manual).

The alternate brake pressure can be checked by installing a pressure gauge on the pneumatic panel. Check the time required to reach full alternate brake pressure. This can be adjusted on the variable restrictor.
When turning the knob from HOLD to OFF check the time required for pressure release to 100 psi (see maintenance manual).

END

50.0 NOSE WHEEL STEERING SYSTEM (Walter Kidde)

The nose wheel steering system is mechanically and electrically controlled and pneumatically operated at a pressure of 100 psi.

The power steering is operative within a range of 70 degrees on either side of the centre line and free castoring within a range of 360 degrees.

Power steering or free castoring can be selected from the cockpit by means of a steering switch (ON - OFF) on the LH side panel. This switch controls a solenoid operated (shut-off) steering control valve. Power steering is accomplished by a steering wheel on the cockpit left-hand side panel. (A steering wheel on the right-hand side panel can be installed as customer requirement.)
Free castoring is used during towing or to taxi the aircraft when no power steering is available.

To ensure that the nose wheel is in the centre upon retraction, a pneumatically operated centering mechanism is installed operating at a pressure of 1000 psi. This mechanism is operative as long as the normal pneumatic supply system is pressurized. It also acts as a shimmy damper.

50.1 Nose Wheel Steering Control Mechanism

The input from the steering wheel is transmitted via drive shafts, a cable drum and cables to a selector drum which is part of a follow-up control valve installed on the forward pressure bulkhead. A painted mark on the steering wheel and the left-hand panel shows the centre position of the system.

Installed in the follow-up control valve is a sliding cam block provided with two tracks. The lower one is provided with two cams and houses a roller linked to the selector drum. The upper one is flat and houses a roller linked via a rocker arm to two inlet valves, one for the left-hand turn the other for the right-hand turn. When the roller on the lower track is in between the two cams both inlet valves are closed which means, that no air pressure is supplied to the steering actuator. This is the case any time no steering selection is made.

50.2 Steering Selected

When the steering wheel is selected the selector drum drives the roller over the relevant cam thereby moving the cam block. The upper roller follows and will open either of the inlet valves thus supplying air pressure to the steering actuator which turns the nose wheel.

50.3 Follow-up

The follow-up mechanism is installed to stop nose wheel turning when the selected position (of the steering wheel) is reached, by closing both inlet valves in the follow-up control valve. The movement of the steering actuator is fed back to the cam block (in the follow-up control valve) via a rack (operated inside the hollow pivot shaft), a pinion and a bell crank. The latter transmits the input from the steering actuator to the rack. A T-slot in the pivot shaft will allow bell crank movement and also allows the bell crank to rotate during nose gear retraction. When it moves it drives the pinion which is connected to the cam block thereby rotating the cam block until the roller in the lower track is again between the two cams, which closes both inlet valves and stops nose wheel movement.

50.4 Steering Control (shut-off) Valve

The steering control valve is solenoid operated and installed on the forward pressure bulkhead right-hand side. When energizing the solenoid the valve opens allowing the 100 psi air pressure to be supplied to the follow-up control valve.

The solenoid is controlled via the:

a. steering switch installed in the cockpit.
b. right-hand ground/flight switch on the right-hand main gear.
c. 70 degrees limit switch on top of the nose gear and operated by a cam.

The solenoid is energized thereby opening the valve when the:

a. steering switch is in ON.
b. aircraft weight is on the wheels.
c. steering angle is within 70 degrees.

Consequently after lift-off the nose wheel steering system is automatically made inoperative.

50.5 Clutch Control Valve

This valve is solenoid operated and installed on the nose gear main fitting to be used to direct pressure to a clutch mechanism in order to engage the steering actuator to an air motor used to drive the steering actuator.

The solenoid is energized when the:

a. aircraft is on the ground via the RH ground/flight switch.
b. steering switch is in ON.

The electric power for both solenoids is supplied by the 28 V main DC bus.

50.6 Steering Actuator

The steering actuator assembly contains the following main components:

a. The control valve porting pressure coming from the follow-up control valve to drive the air motor.
b. The air motor driven by air pressure by means of internal vanes. This rotation is transmitted via a sun gear and a clutch mechanism (operated via the clutch control valve) to a pinion gear. This input is transmitted via a sun gear and five planet gears to the gear box plate assembly connected to the nose wheel pivot bracket.

50.7 Centring Mechanism

This mechanism is installed to centralize the nose wheel when the steering control valve is de-energized as it is for instance after lift-off and also to dampen the motion when the nose wheel is subject to bumps during taxying. The centralizer unit is operating at 1000 psi supplied directly from the normal supply system. The housing is fixed and the piston is connected to the rotatable gear box plate assembly. A check valve prevents air pressure to dissipate to ambient when there is no air supply. When the nose wheel is turned the piston inside the centralizer unit moves thereby decreasing the cylinder volume and increasing the air pressure. So any time the nose wheel is not in centre the increased air pressure acts on the piston thus trying to centre it. After lift-off when there is no load on the nose wheel the piston will move it to the centre position.

50.8 Pneumatic Lubricator

A pneumatic lubricator is positioned in one of the lines downstream the follow-up control valve. It provides a metered quantity of oil for lubrication of the air motor. A combined dipstick/filler cap permits checking the oil level and refilling.

50.9 Check Valves

Two check valves are incorporated in the system. One is installed in the line by-passing the pressure reducing valve. It allows the pressure in the system to release to atmosphere via the exhaust of the steering control valve when the system is switched off. The other check valve is mounted to a manifold on the nose gear pivot bracket. It prevents the centralizer unit from becoming depressurized.

50.10 Pressure Reducer

A 1000 to 100 psi pressure reducer is used to reduce the 1000 psi pneumatic pressure routed from the pneumatic panel manifold. The valve is mounted to the front side of the pressure bulkhead.

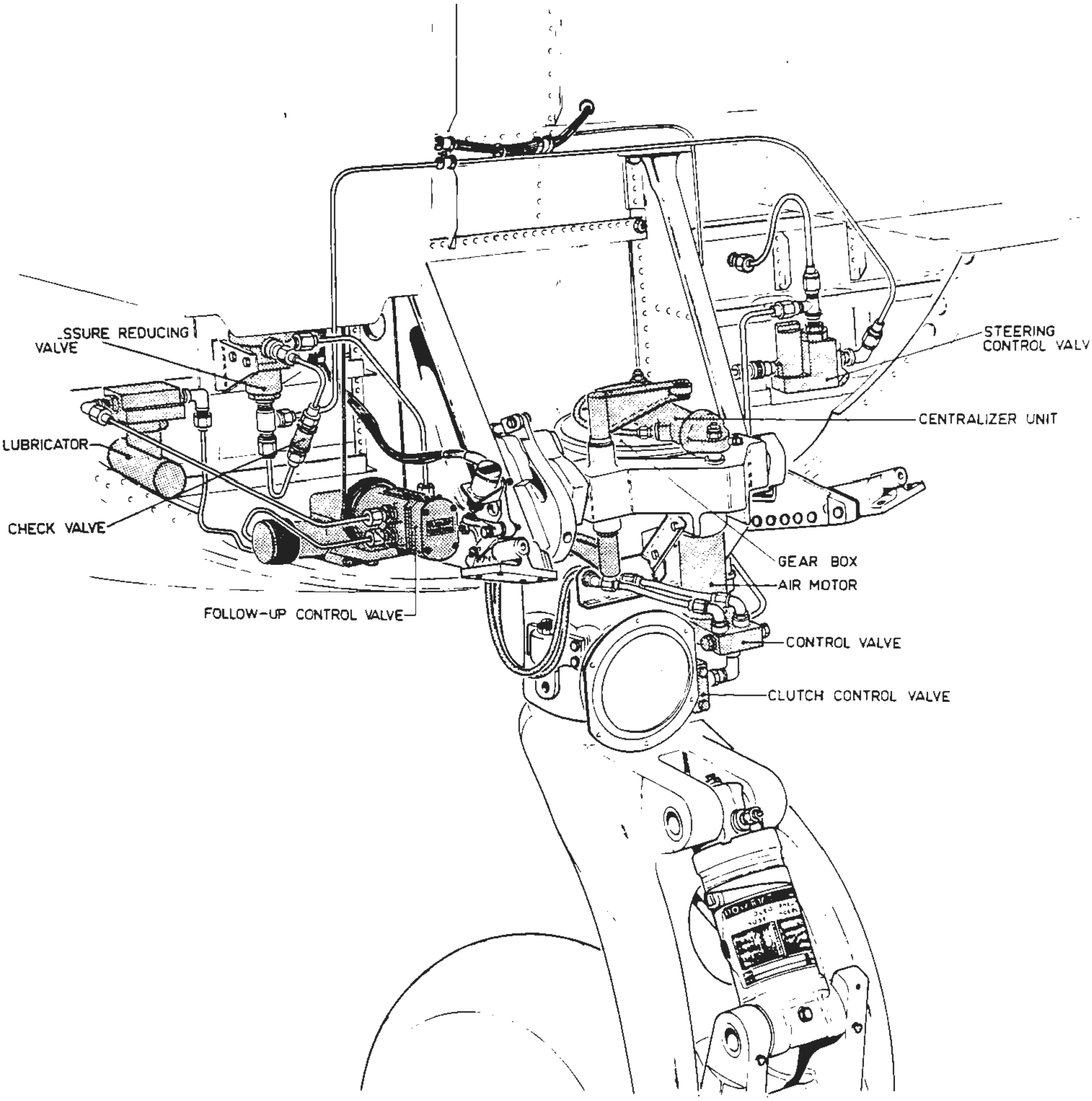
50.11 Nose Wheel Steering Test

When testing this system the nose wheel must rest lightly on the ground. Compress the right-hand ground/flight switch (ground position). With the steering switch ON select steering wheel in left-hand and right-hand direction and check that the wheel follows accordingly. Release steering wheel and check that the wheels return to the centre position automatically. Check that the steering control valve solenoid de-energizes when the:

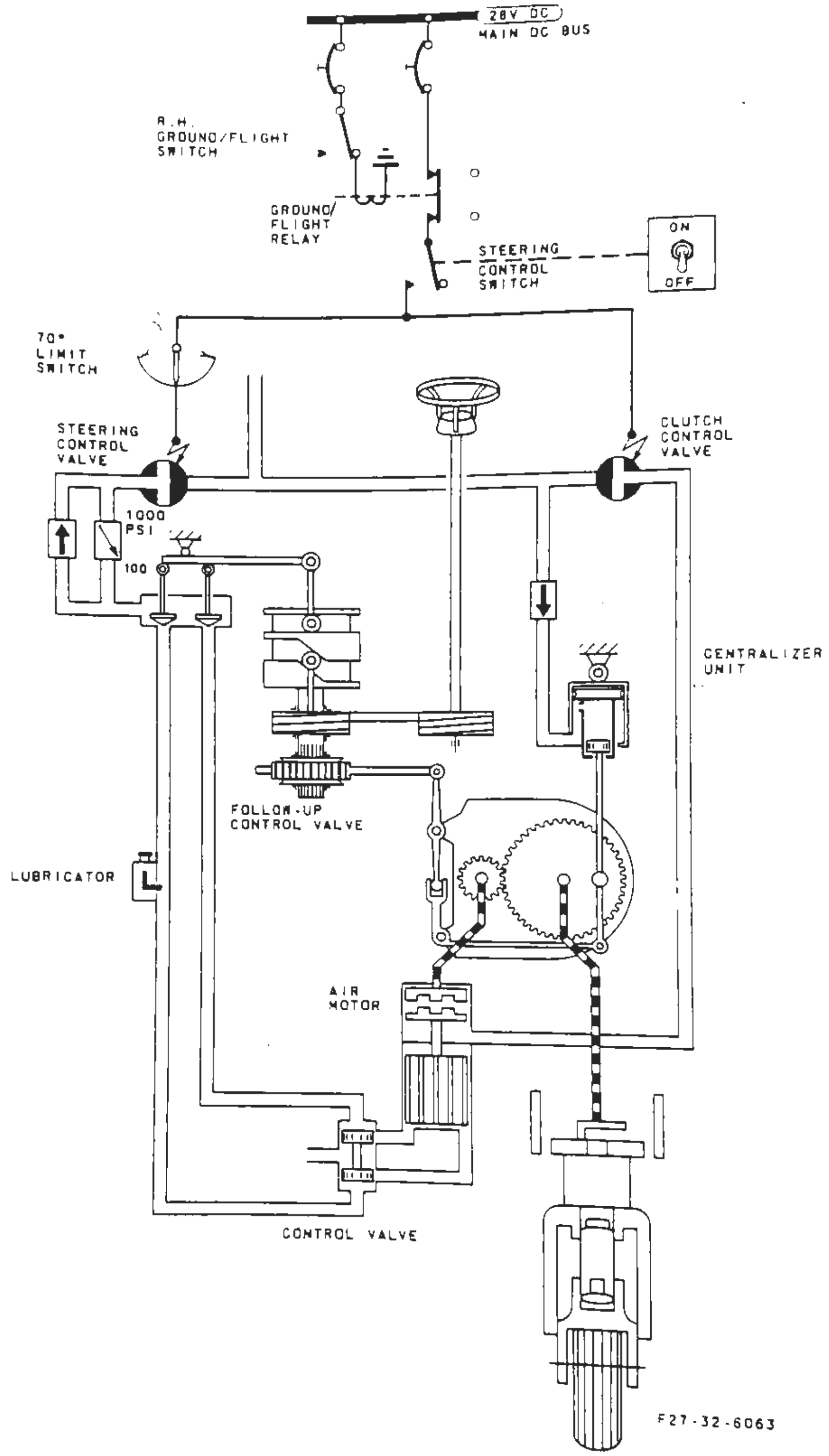
a. RH ground/flight switch is in flight position.
b. nose wheel steering switch is in OFF.
c. steering angle is 70° or above.

With the steering switch in OFF check that 360 degrees rotation can be made without any obstruction.

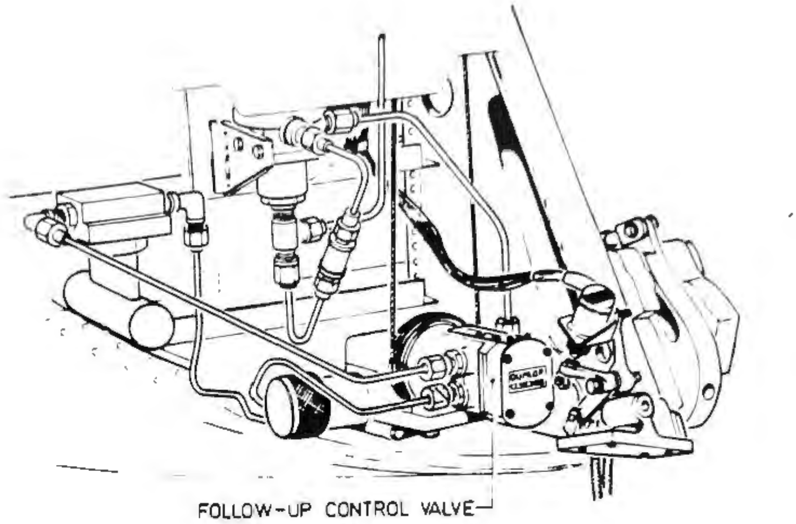
END

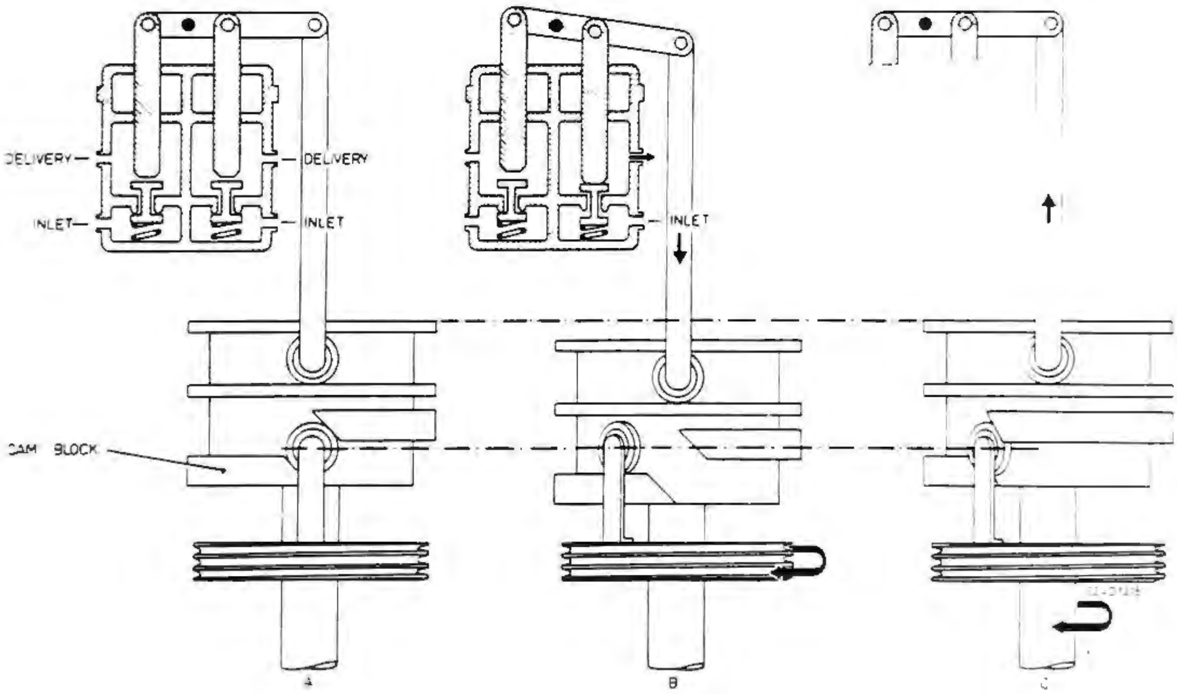


NOSE WHEEL STEERING SYSTEM - LOCATION OF COMPONENTS

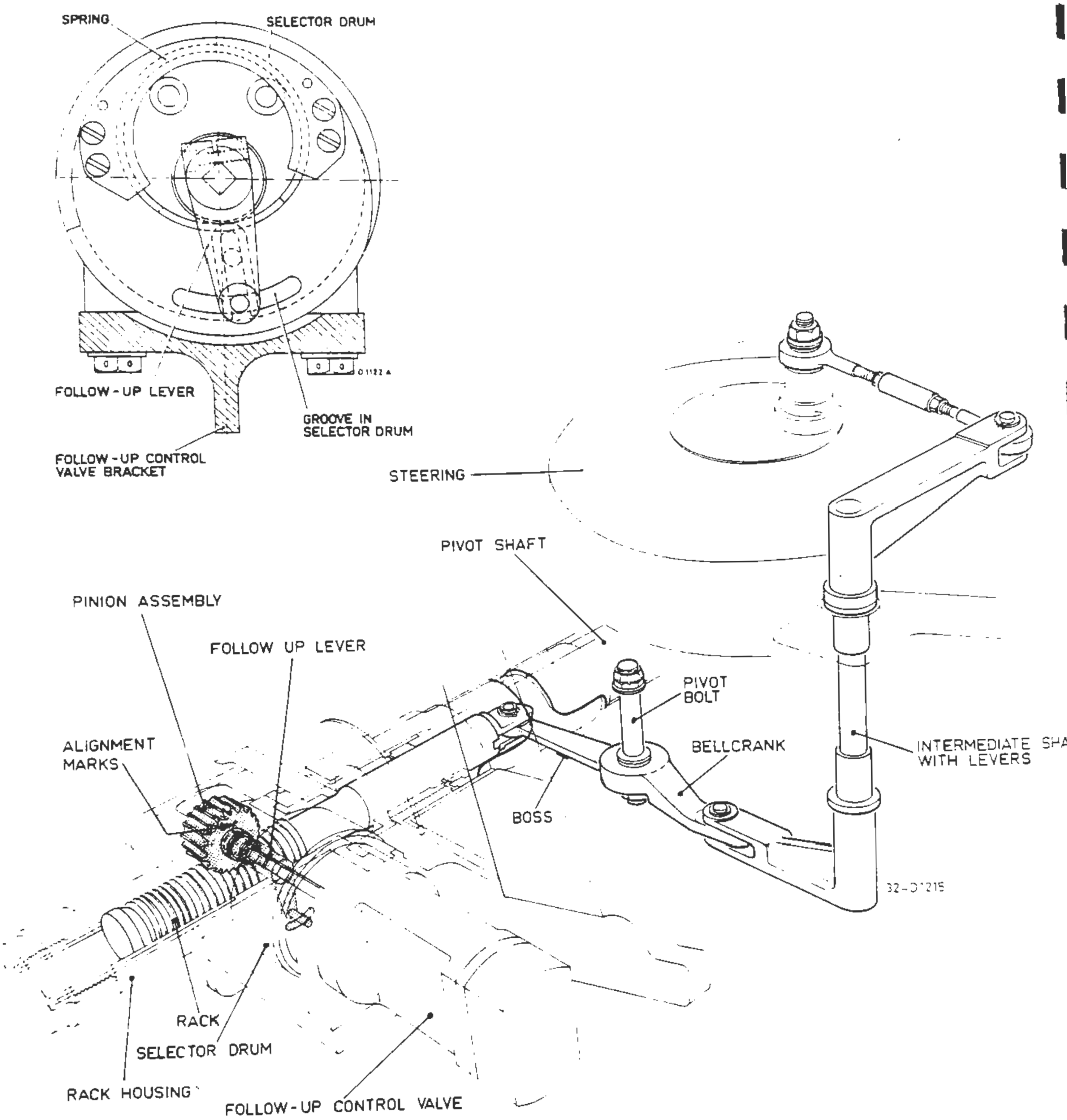


NOSE WHEEL STEERING SYSTEM

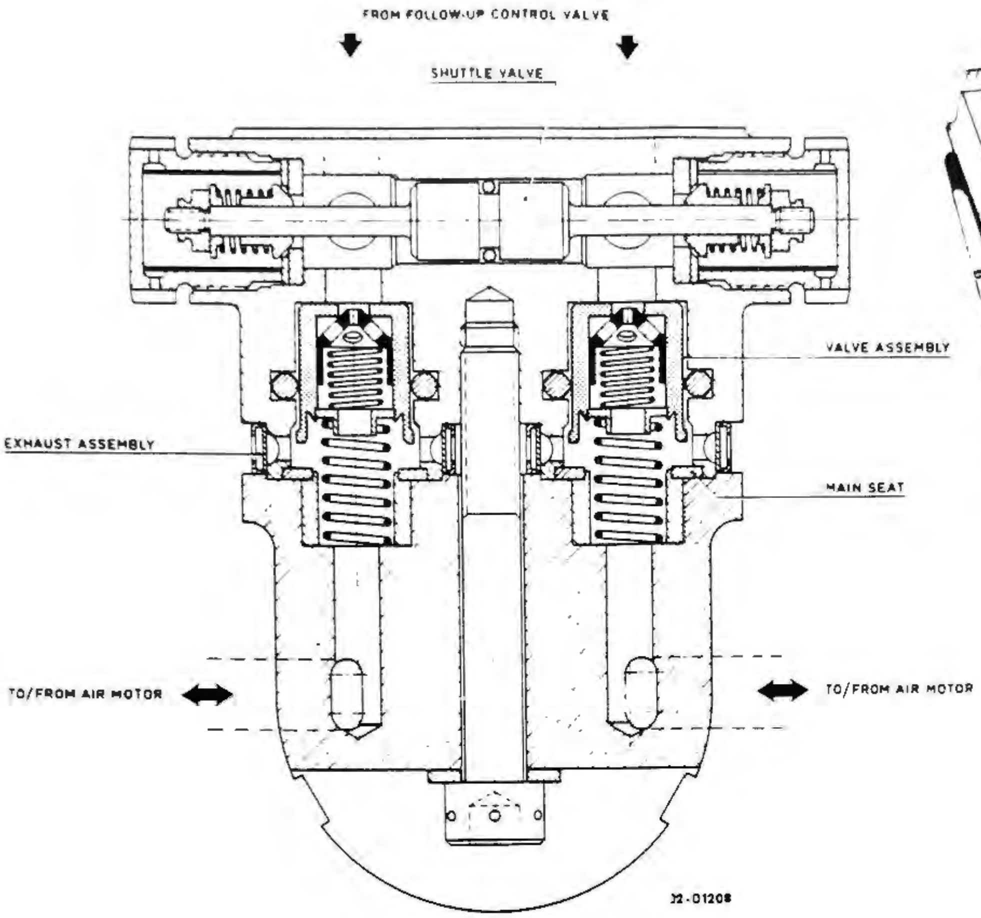


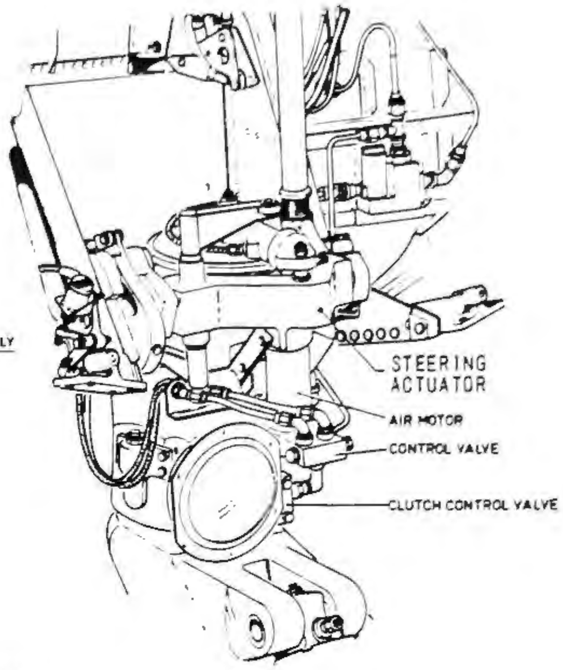


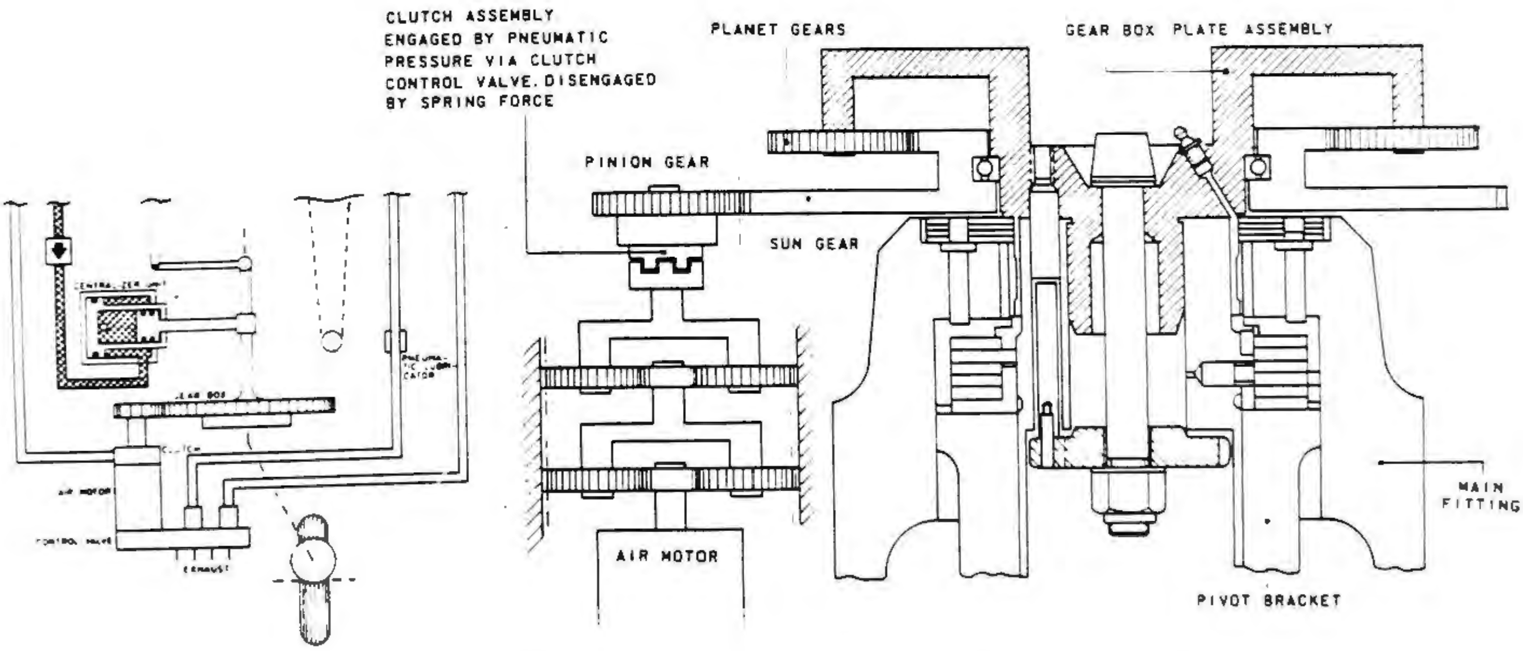
FOLLOW-UP CONTROL VALVE OPERATION



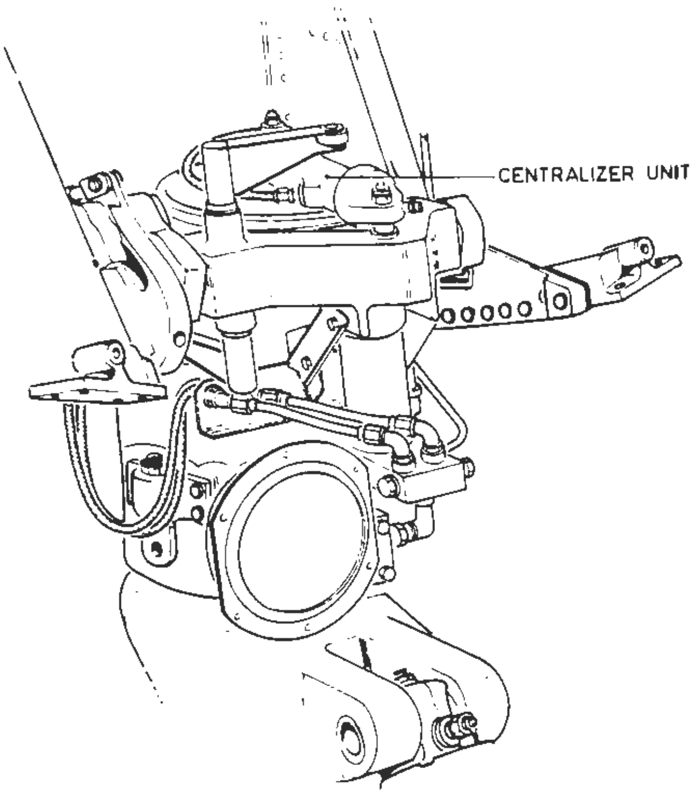
NOSE WHEEL STEERING FOLLOW-UP MECHANISM

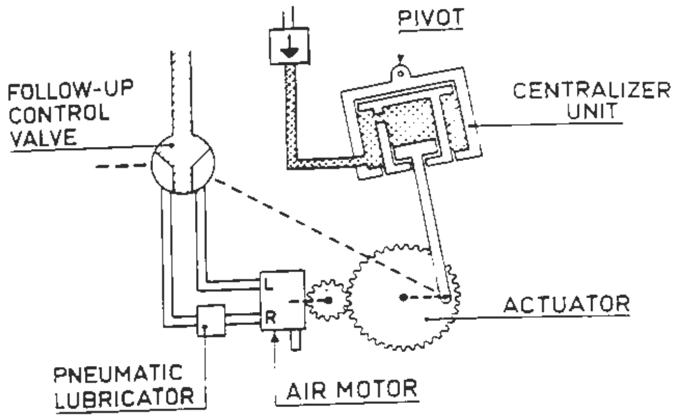




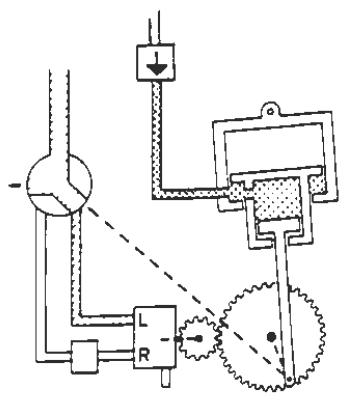


NOSE WHEEL STEERING - ACTUATOR AND CONTROL VALVE

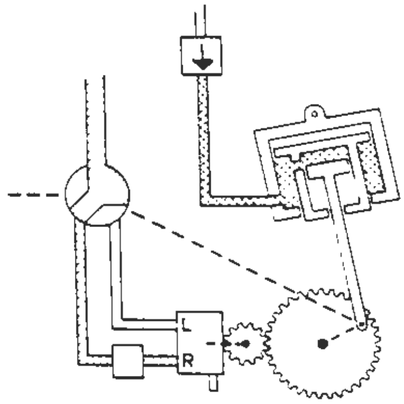




CENTRE POSITION



L.H. TURN



R.H. TURN

CENTERING MECHANISM

60.0 LANDING GEAR POSITION INDICATION AND WARNING SYSTEM

The landing gear position is indicated by the red and green lights of a landing gear position indicator and additionally for the nose gear by a second downlock indicator light (green). Both indications are installed on the main instrument panel.
The landing gear warning system will sound a warning horn in the cockpit (behind LH vertical side panel) when during the approach, the landing gear is not down and locked.

60.1 Landing Gear Position Indication

The landing gear position indicator is equipped with three sets of red and green lights, one set for each gear.
The indications are as follows:

Gear down and locked	: Green lights via the downlock microswitches.
Gear unlocked	: Red lights via the unlocked position of the downlock switches and the uplock switches (no. I and no. II for the main gear).
Gear up and locked	: No lights. The locked position of the uplock switches (no. I and no. II for the main gear) has interrupted the circuit.

A night screen lever on the indicator, when operated, will dim the intensity of the lights by turning a screen behind the indicator windows.
Electric power for the indicator is supplied by the 28 V DC main tie bus.

The second nose landing gear downlock indicator light is supplied from the 28 V DC essential bus and is illuminated whenever the microswitches II (gear down) and III (gear locked) are operated. The dim circuit is incorporated in this indication.

60.2 Landing Gear Warning System

The system consists of:

- a primary warning system and
- a secondary warning system

Primary Warning

This warning sounds when:

a. Either rpm lever is below 10,500 rpm and
b. Any of the gears is not down and locked.

A silencer switch on the pedestal can be used to silence this warning. Pushing the switch will energize a silencer relay with hold-in circuit which interrupts the horn circuit. The warning system is re-armed when either rpm lever is advanced above 10,500 rpm or all gears are down and locked.

Secondary Warning

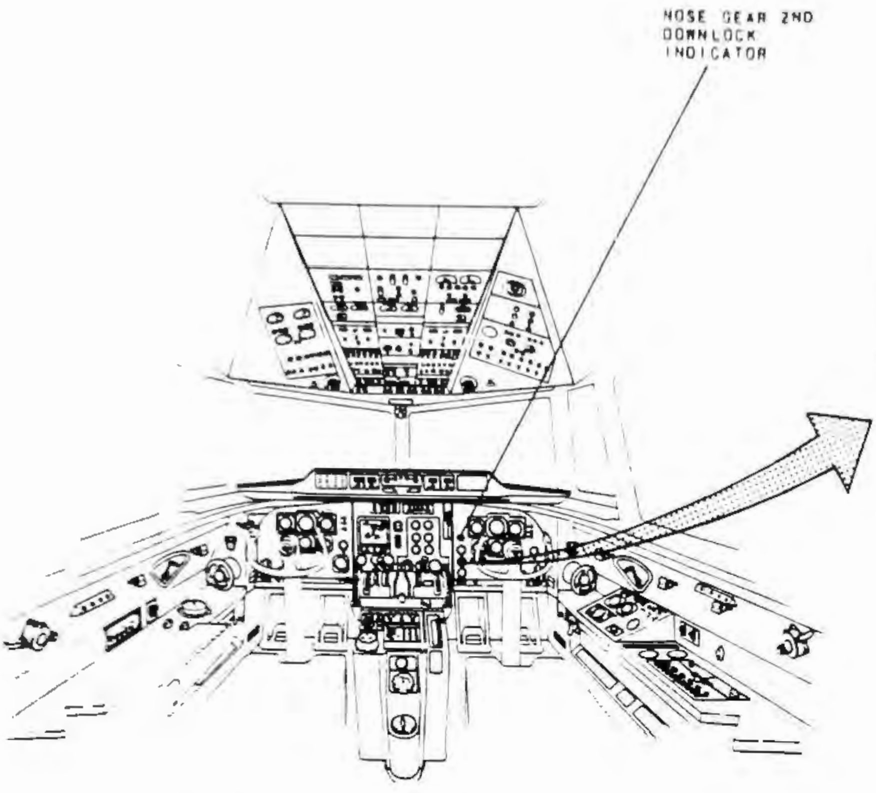
This warning sounds when:

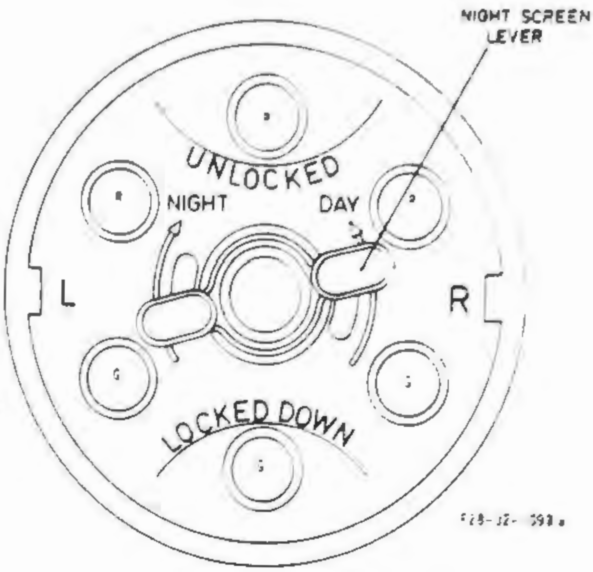
a. Any gear is not down and locked and
b. The flaps are beyond the 25 degrees position (28 degrees for military aircraft)

To this end a switch is installed on the outboard flap spindle LH nacelle and operated by the flap drive nut.

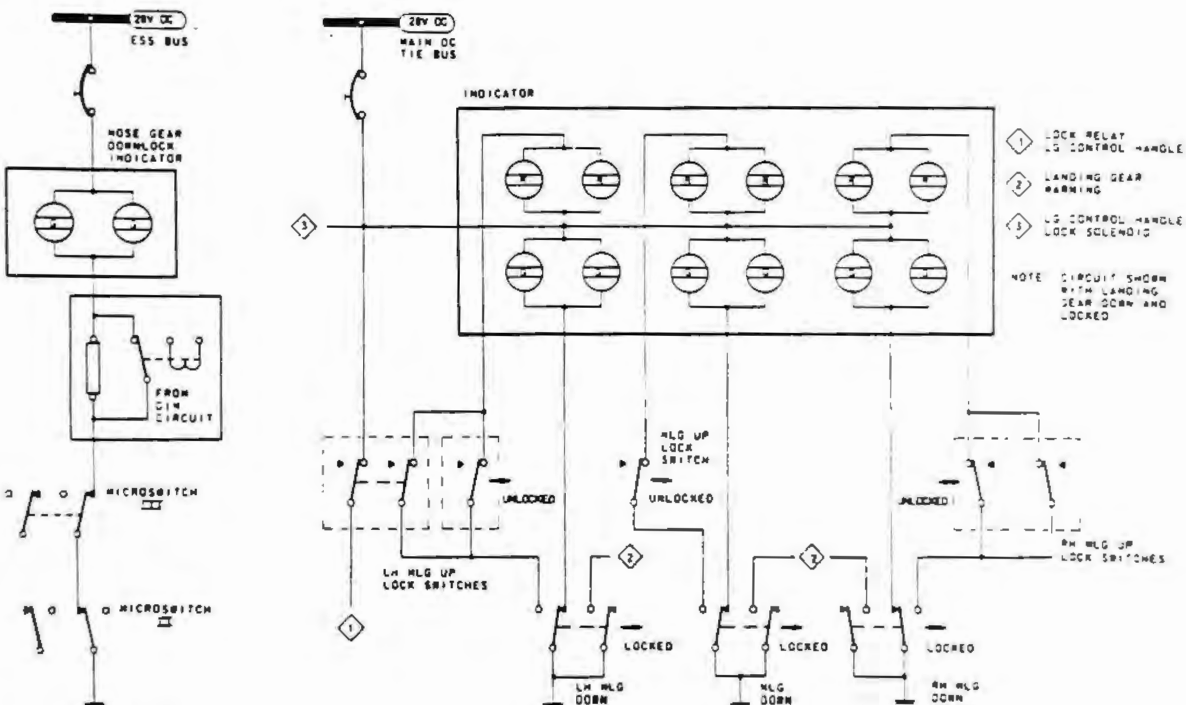
The warning system can be tested by means of a test switch on the LH vertical side panel. Operation of this switch simulates an unlocked gear. Electrical power for the warning system is supplied from the 28 V DC main tie bus.

END

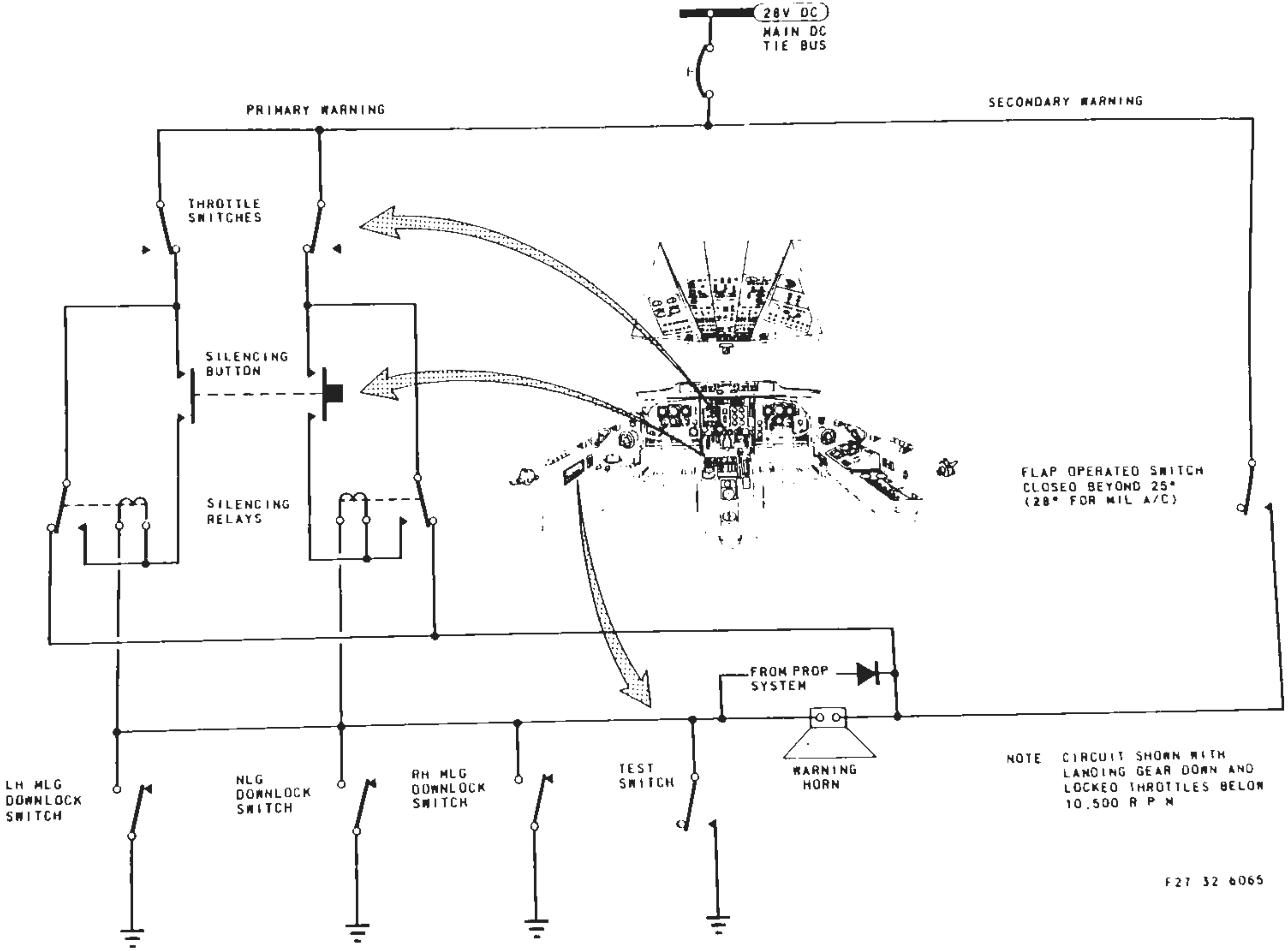




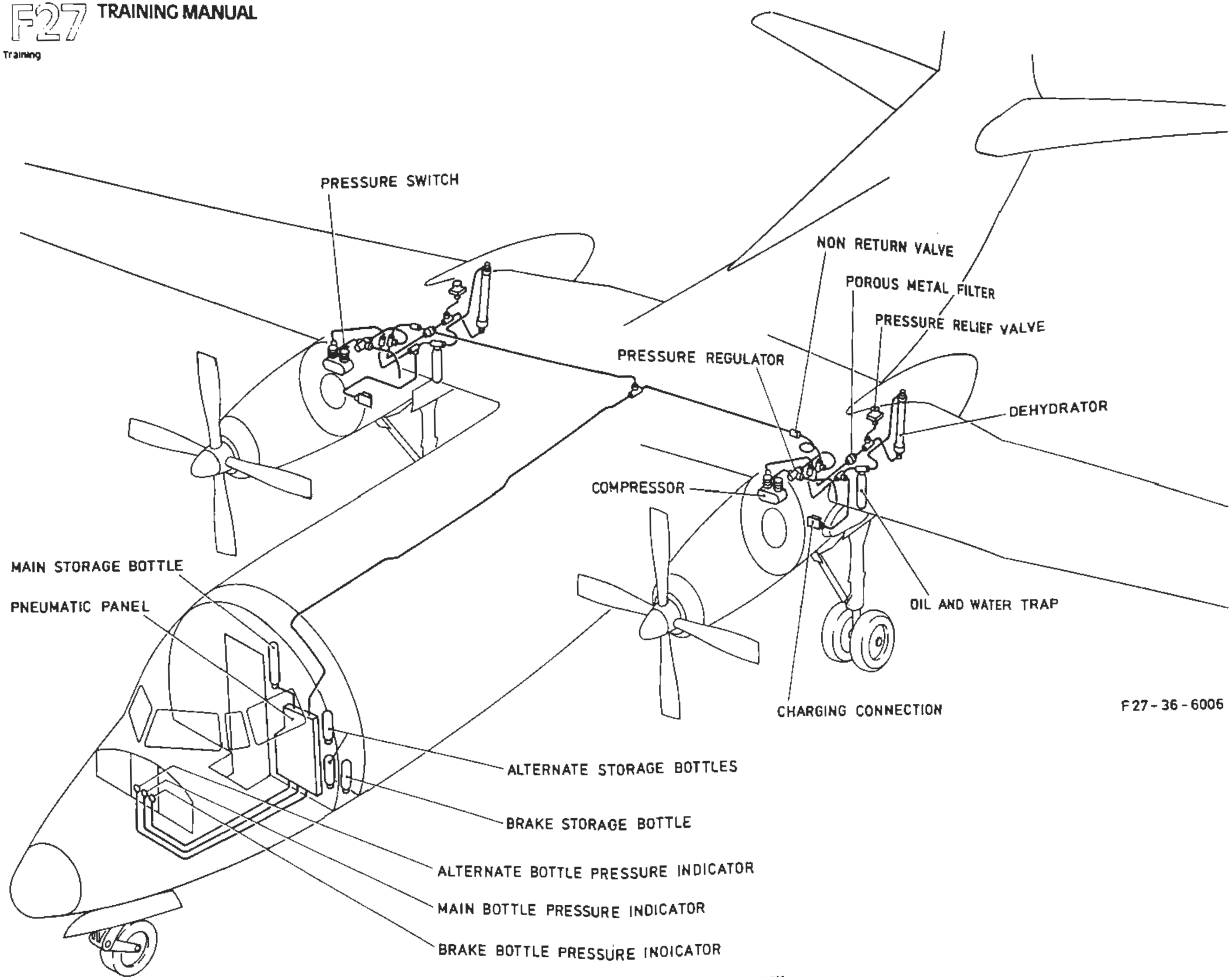
POSITION INDICATOR



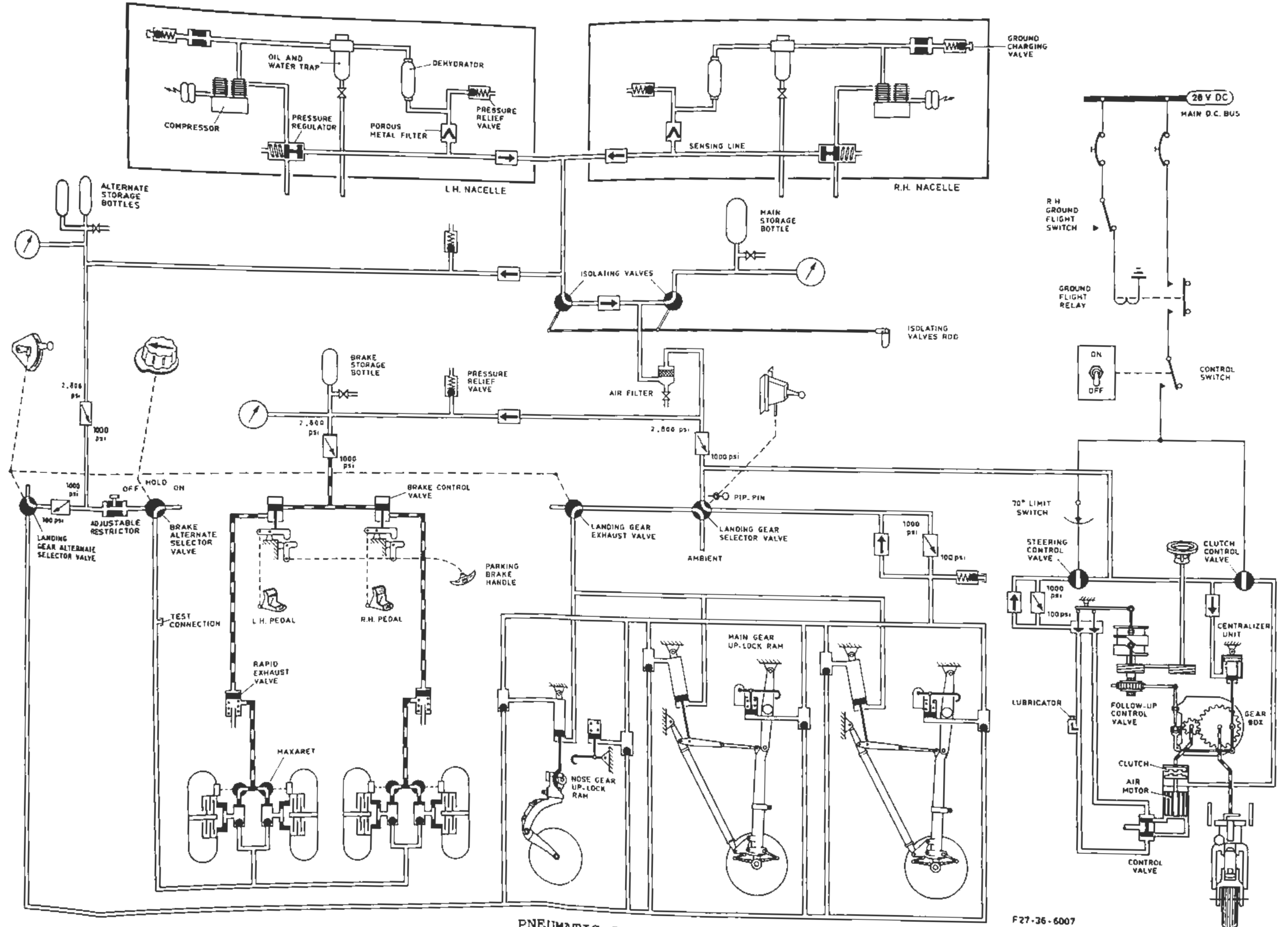
LANDING GEAR POSITION INDICATION



LANDING GEAR WARNING



PNEUMATIC SYSTEM GENERAL INFORMATION



PNEUMATIC SYSTEM

33. LIGHTS

33. LIGHTS

00.0 GENERAL

The lights of the aircraft can be divided in the following groups:
- Cockpit lighting
- Passenger compartment lighting
- Cargo compartment and service compartment lighting
- Exterior lights
- Emergency/night and evacuation lights.

10.0 COCKPIT LIGHTING

General cockpit lighting is provided by dome lights, located in the cockpit ceiling, containing two white and one red fluorescent-type light. One white light is controlled by a push button or the STORM switch, the red light by the RED DOME light switch on the overhead panel. The red light and one white light are also on when essential power is selected.

A multi-purpose light, dimmable and incorporating red/white selection possibilities is located on the wall behind the pilot. The light is directly supplied from the battery bus and must be checked switched off when leaving the aircraft.

General main instrument panel lighting is by 5 white and 5 red fluorescent-type lights.
The white lights are controlled by an OFF-DIM-BRIGHT switch or by the STORM switch; the red lights are supplied via a variable transformer, operated via a rotary switch on the LH side panel.

The instruments and instrument panels have integral lighting by small bulbs which receive 5 V maximum via step-down transformer. Light intensity is selected by 4 rotary switches on the secondary instrument panel for the LH main instrument, centre main instrument panel, RH main instrument panel and glareshield panel and pedestal respectively. A rotary switch on the overhead panel controls the intensity of the integral overhead panel lighting.
The stand-by compass lighting is controlled by a separate switch on the lower side of the overhead panel.

Side panel lighting is performed by variable intensity lights being controlled by rheostats on the side panels. For reading two reading lights are installed in the overhead panel. The light color can manually be changed from white to red while the control switches are next to the lights.

AC power for the fluorescent-type lights in both cockpit and cabin, as well as for the instruments is supplied by two static inverters which are located under the cargo compartment floor.

10.1 Warning Light System

The master WARNING lights on the main instrument panel are installed to direct the pilot's attention to particular system failures which are indicated by red system warning lights. The red fire warning and feathering pump lights are not related to the master warning system.

When a system warning light comes on, the master WARNING lights come on too. In some cases, however, they remain out. This is applicable to the alternator inoperative, gearbox pressure and engine oil pressure warnings as a result of propeller feathering.

The master WARNING lights can be reset by pushing the master WARNING light assembly.

When the ANN LIGHTS WARN test switch on the test panel (LH side panel) is pressed to TEST the master WARNING lights and all system warning lights come on.

The brightness of some warning, caution and indicator lights is adjustable, setting the INDICATOR LIGHTS switch on the secondary instrument panel in DIM or BRIGHT. The switch is also used to control the dim relays in the inverters, batteries, generators and propeller control panels. All these lights turn to bright when the STORM switch is operated. A few warning and caution lights automatically dim as result of propeller feathering.

10.2 Annunciators and Displays Lighting

The annunciators and displays used in flight instruments and avionics control panels are split up in three groups, i.e. LH, centre and RH main instrument panel.

In each group the brightness of some annunciators and displays is automatically controlled, for others stepwise (bright-dim) only.

- Automatic control
  When the AUTO-MAN switch on the main instrument panel is in AUTO the preset knob is used to set the brightness as required. The brightness of the annunciators and displays is now automatically matched when the ambient light intensity changes.
  When the switch is in MAN the preset knob is only used to set the brightness as required. There is no automatic change of brightness.
  When the previous system fails the brightness of the annunciators and displays is set to dim or bright with the INDICATOR LIGHTS switch on the RH secondary instrument panel.
  When the latter possibility fails too, the brightness of the annunciators and displays turns to bright.
- Stepwise control
  The brightness of the remaining annunciators depends on the position of the INDICATOR LIGHTS switch. When this control fails the brightness turns to bright.

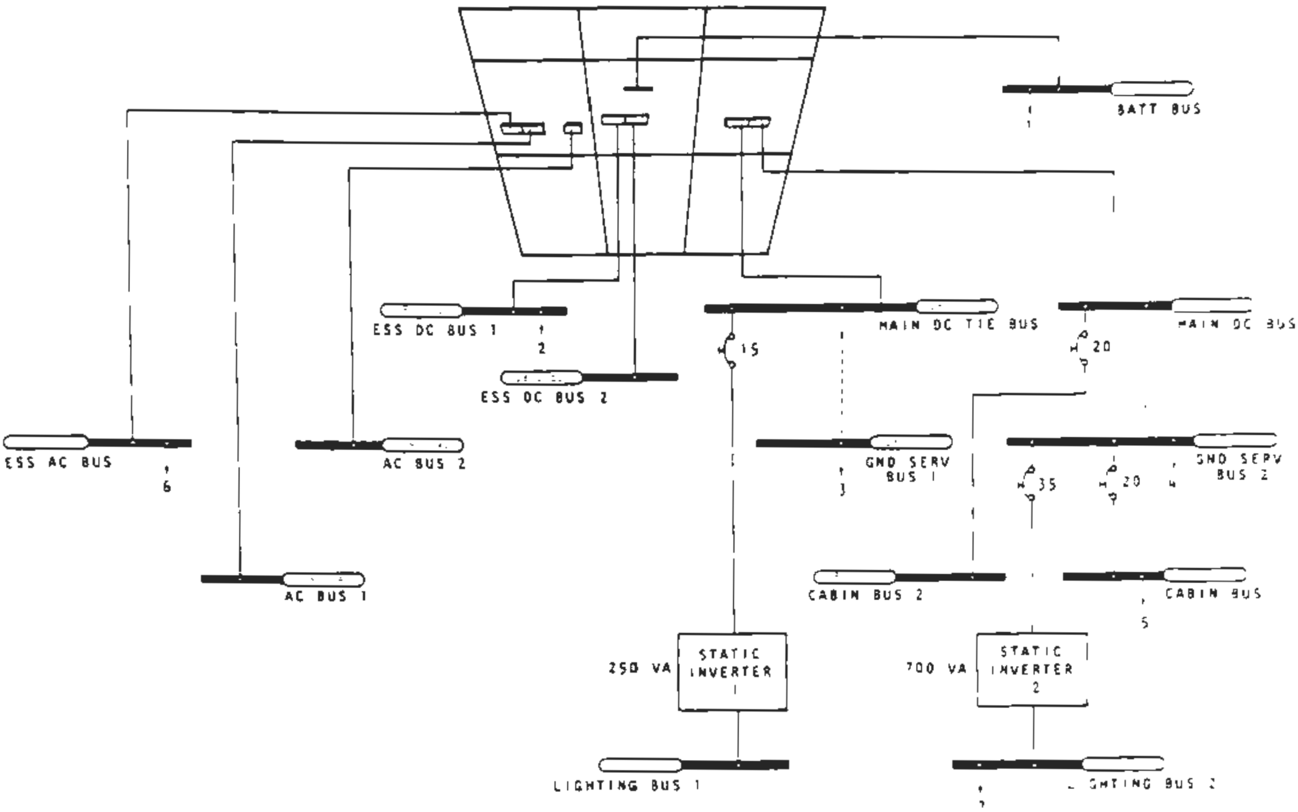
When the STORM switch is operated the brightness of all annunciators and displays turns to full bright.

When ANN LIGHTS MODE STS test switch on the test panel is pressed to TEST all annunciator and display lights come on at maximum brightness.

When the AUTO DIM SELFTEST switch on the maintenance, annunciator and test panel is pressed to TEST, the brightness slowly increases to maximum and then cycles between bright and dim.

Each group has its own dimming unit, which is located under the cargo compartment floor. The ambient light intensity is measured by a number of light sensors in the cockpit, two for each group.

END

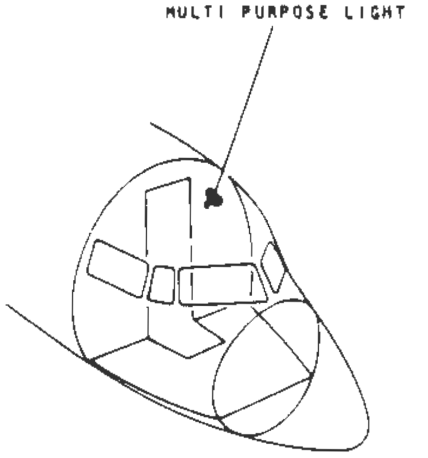


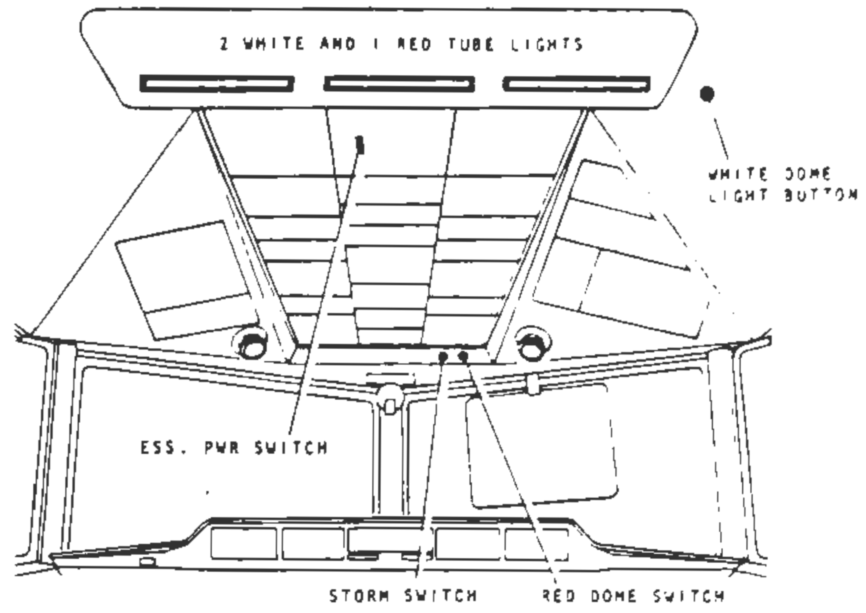
ELECTRICAL BUSES FOR LIGHTING

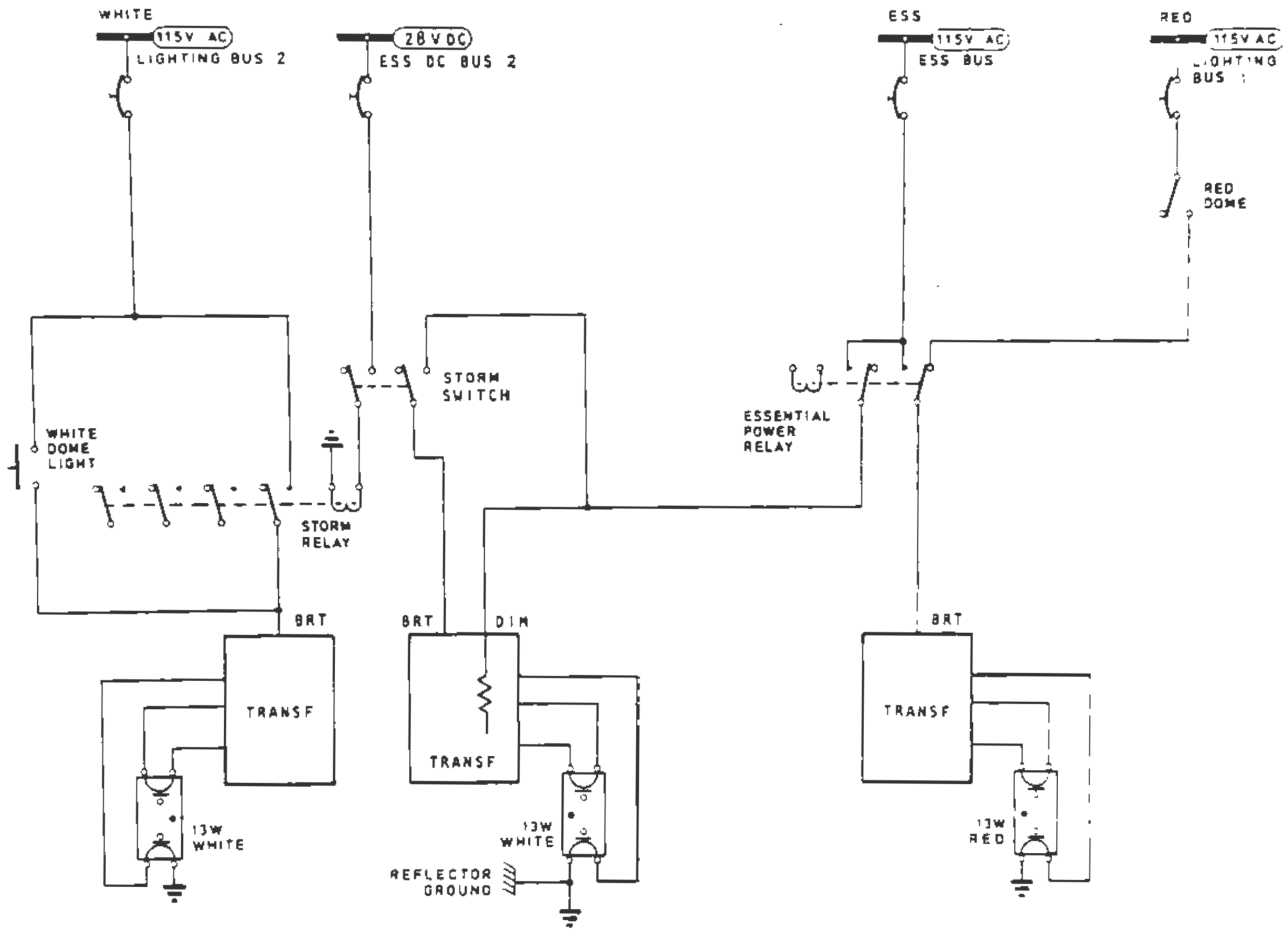
1.	BATT BUS	- MULTI PURPOSE LT - EVAC LTS (ON SWITCHING FROM STEW PANEL)
2.	ESS DC BUS 1	- STAND-BY COMPASS LT - EMERG/[redacted]
3.	GND SERV BUS 1	- NAVIGATION LTS
4.	GND SERV BUS 2	- CARGO COMPARTMENT LTS - WHEEL BAY LTS
5.	CABIN BUS 1	- CABIN ENTRANCE LTS - LUGGAGE COMPARTMENT LT - TOILET COMPARTMENT LT
6.	ESS AC BUS	- COCKPIT ESS DOME LTS - ESS INSTRUMENT LTS
7.	LIGHTING BUS 2	- MAIN INSTR PANEL LTS (RH AND CENTRE) - OVERHEAD PANEL LTS - COCKPIT WHITE DOME LTS - MAIN CABIN LTS

EMER -
EVAC -

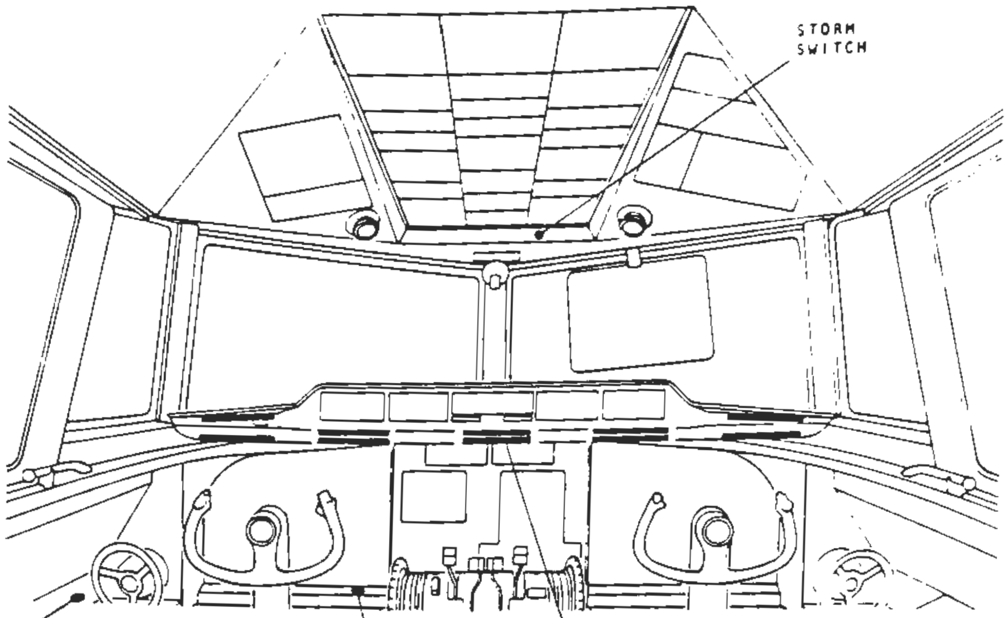
LIGHTS SUPPLIED FROM ESSENTIAL BUSES AND GND SERV BUSES

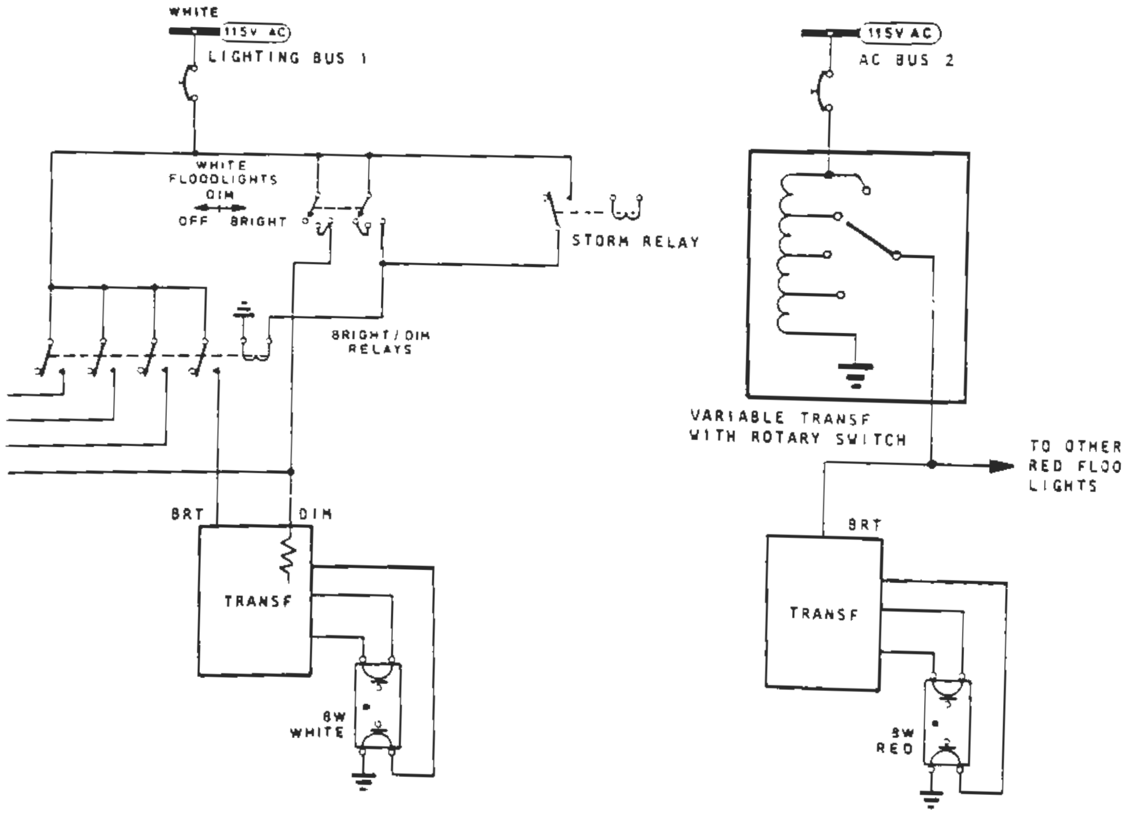




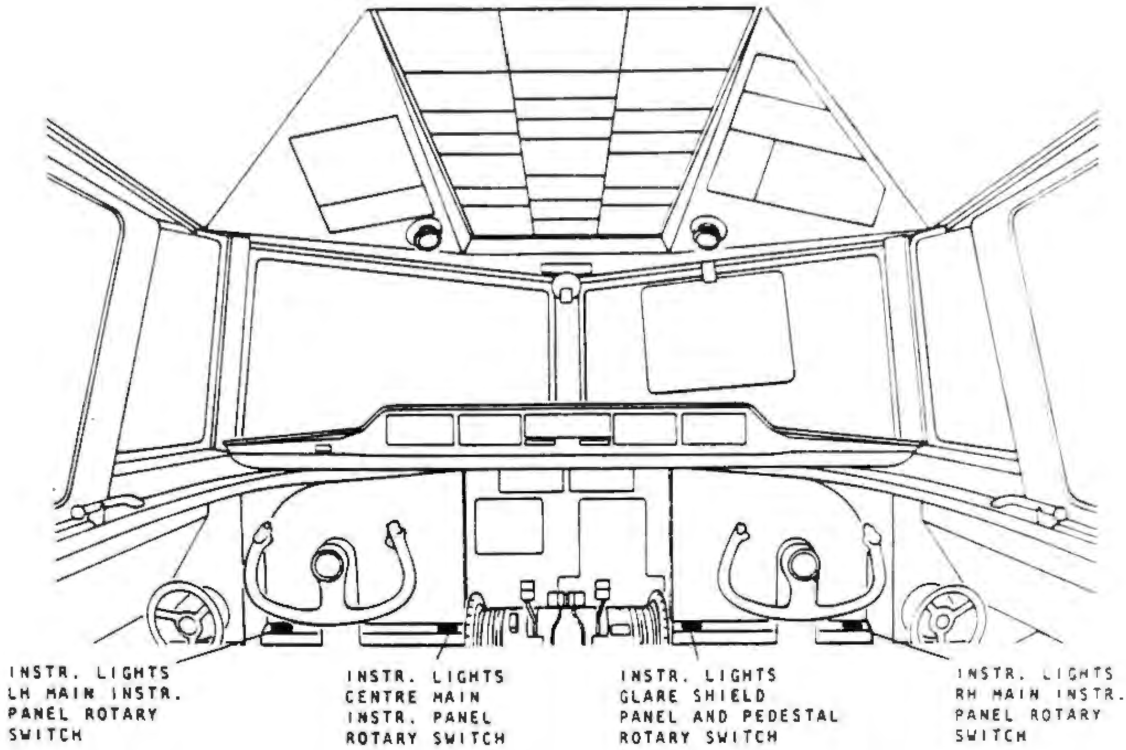


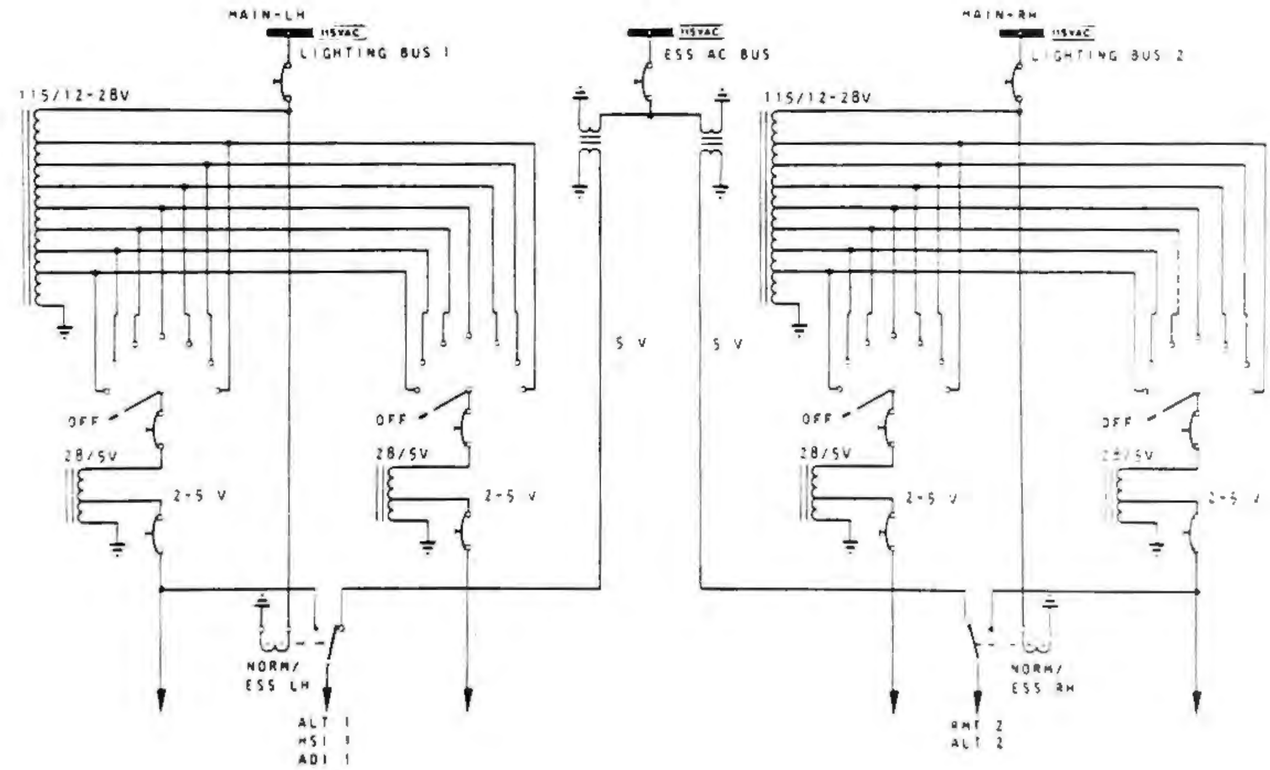
COCKPIT DOME LIGHTS



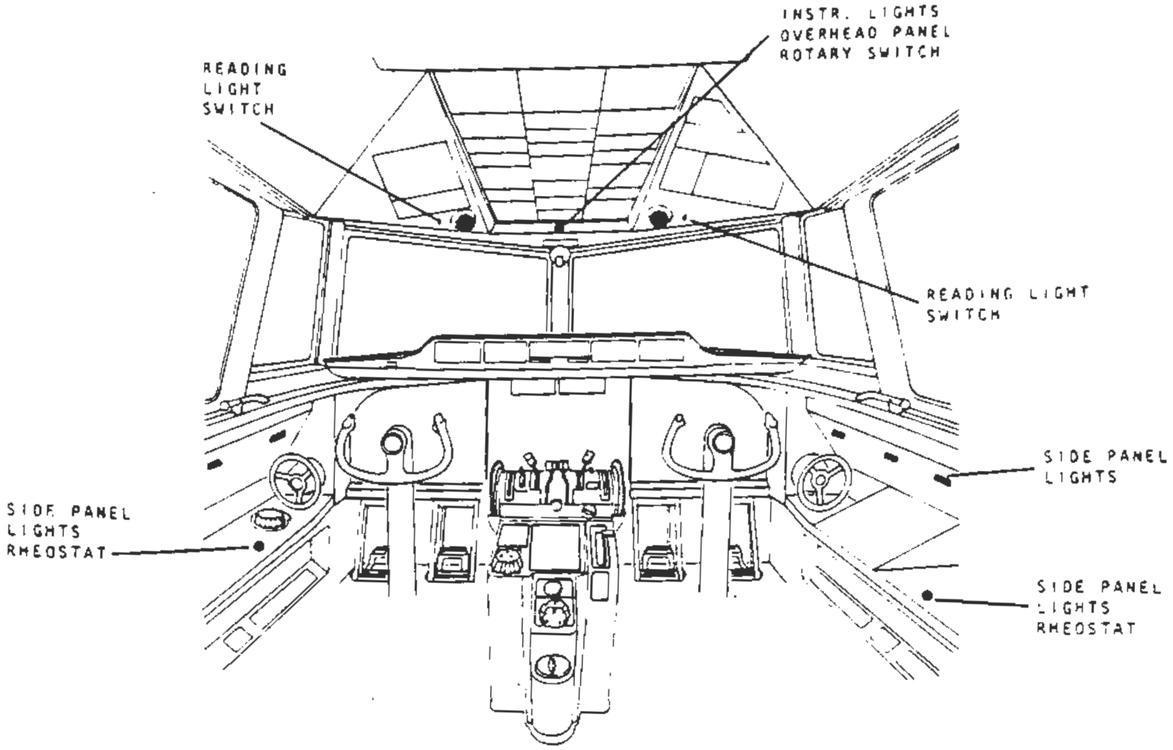


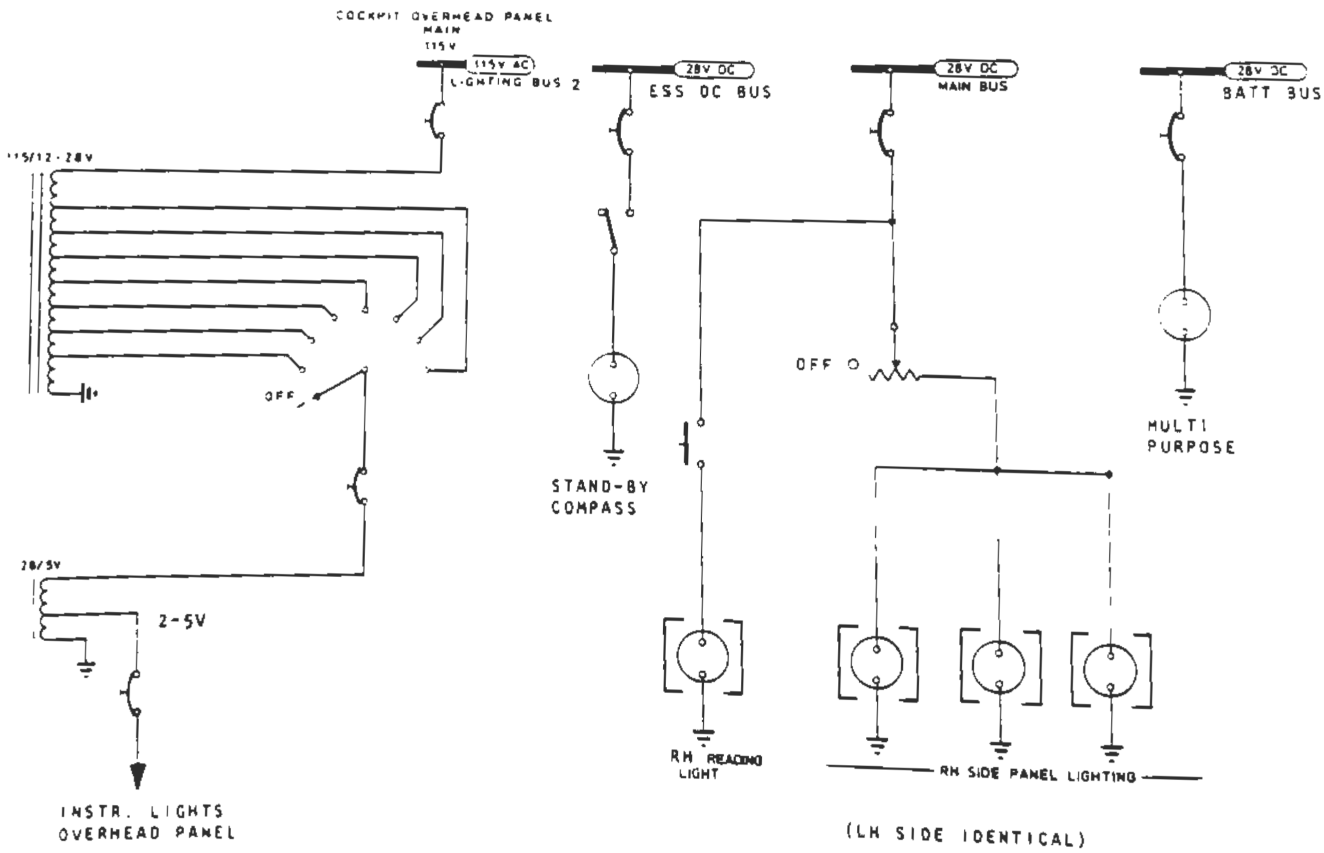
MAIN INSTRUMENT PANEL FLOOD LIGHTS



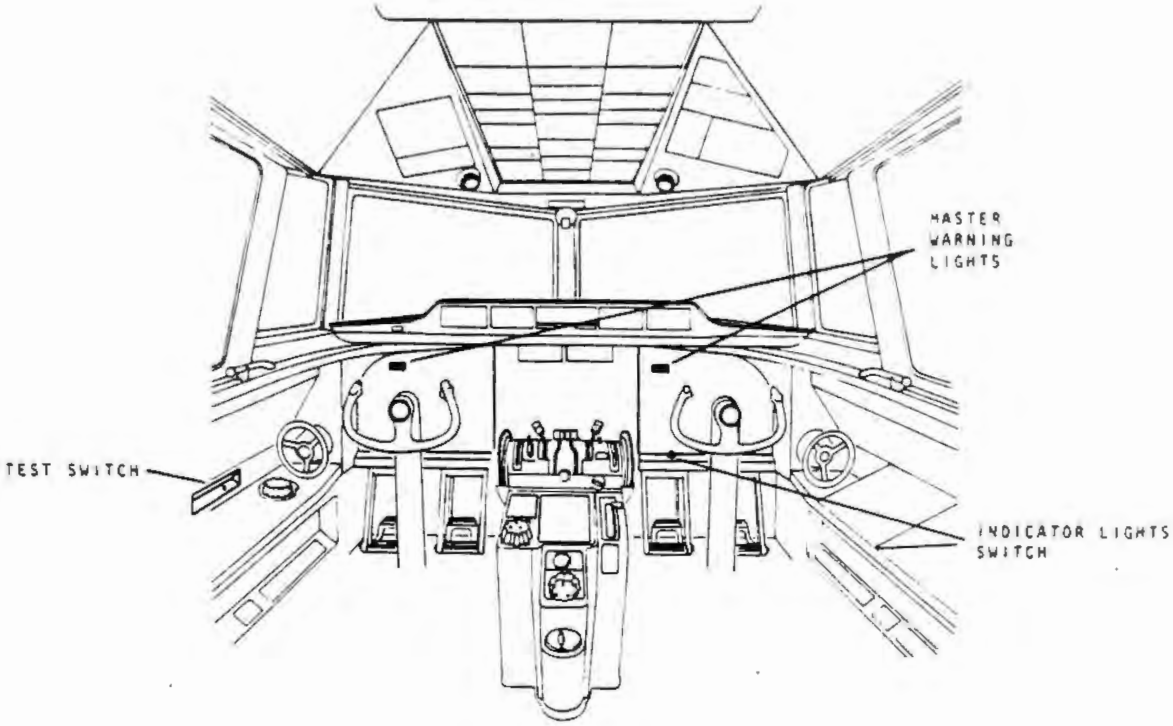


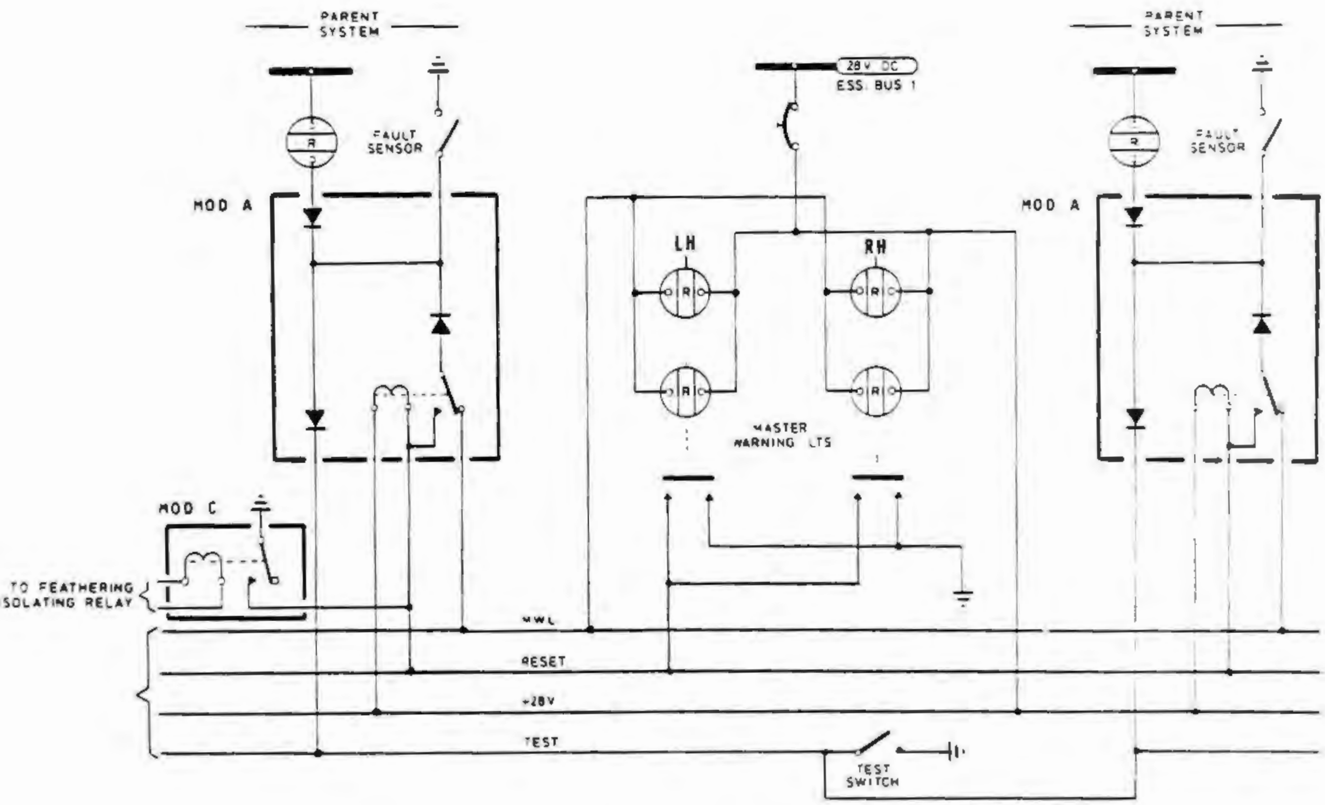
MAIN INSTRUMENT PANEL, GLARESHIELD AND PEDESTAL LIGHTING



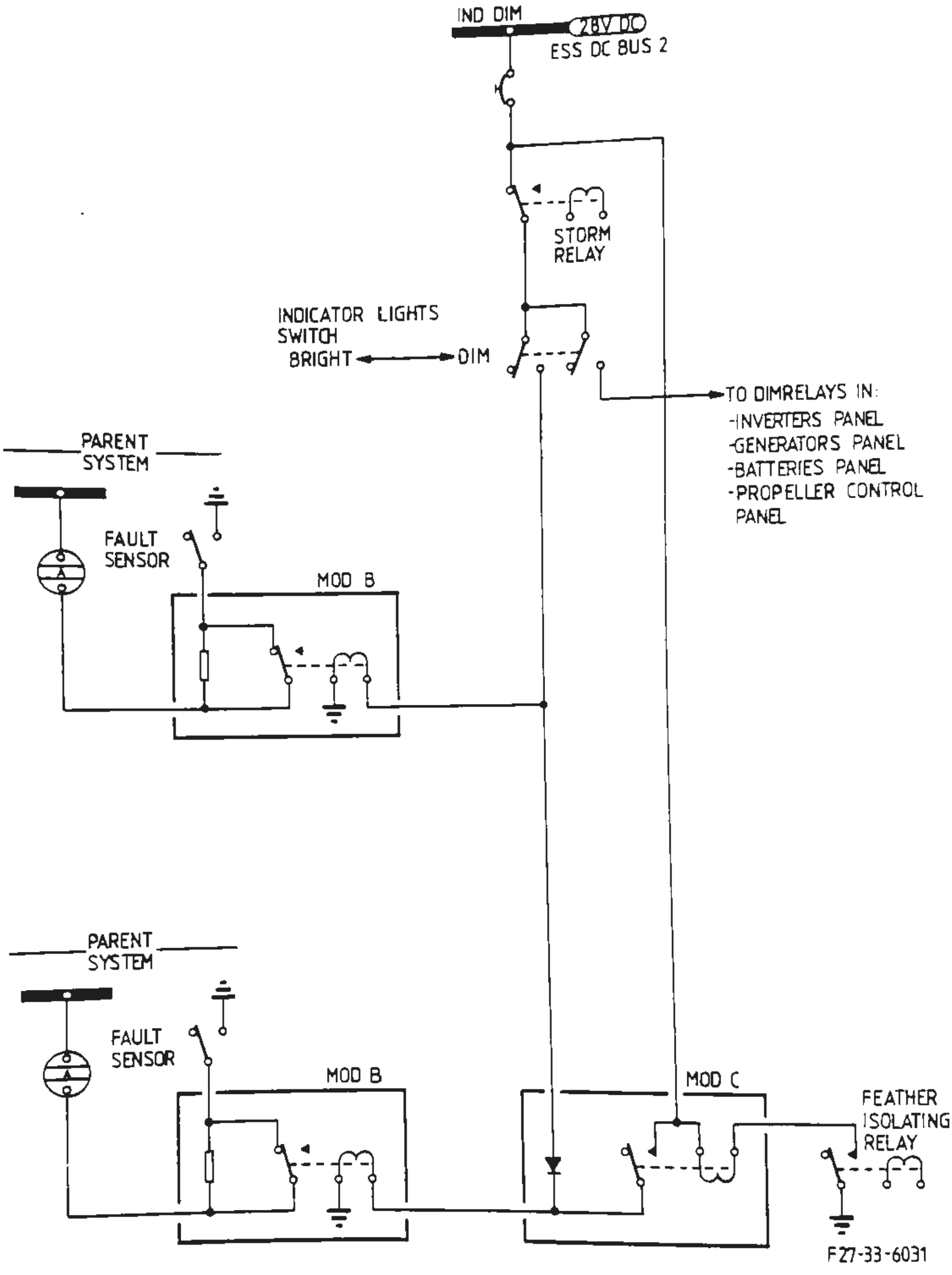


OVERHEAD PANEL AND SIDE PANEL LIGHTING





MASTER WARNING LIGHT SYSTEM

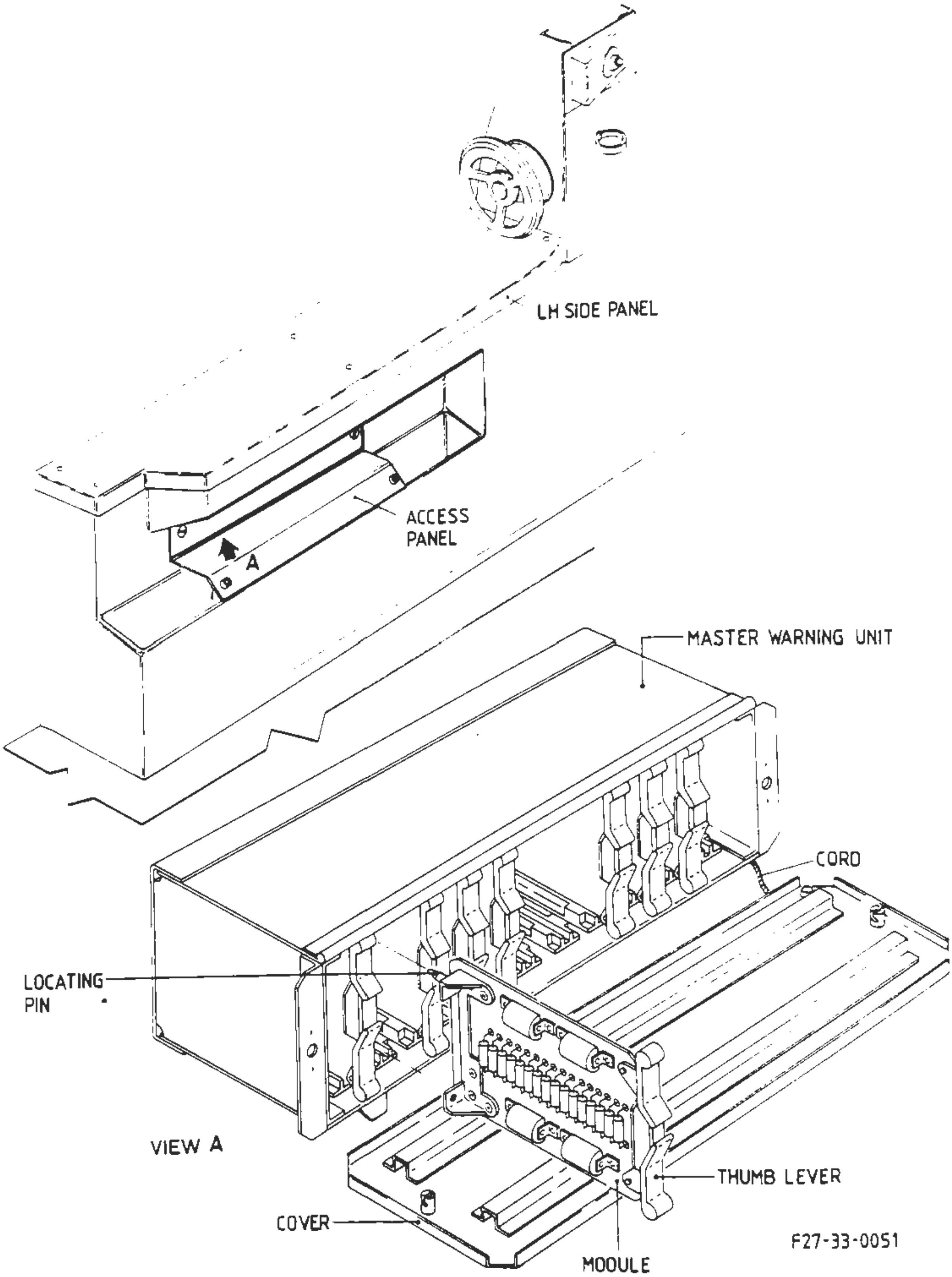


DIMMING SYSTEM

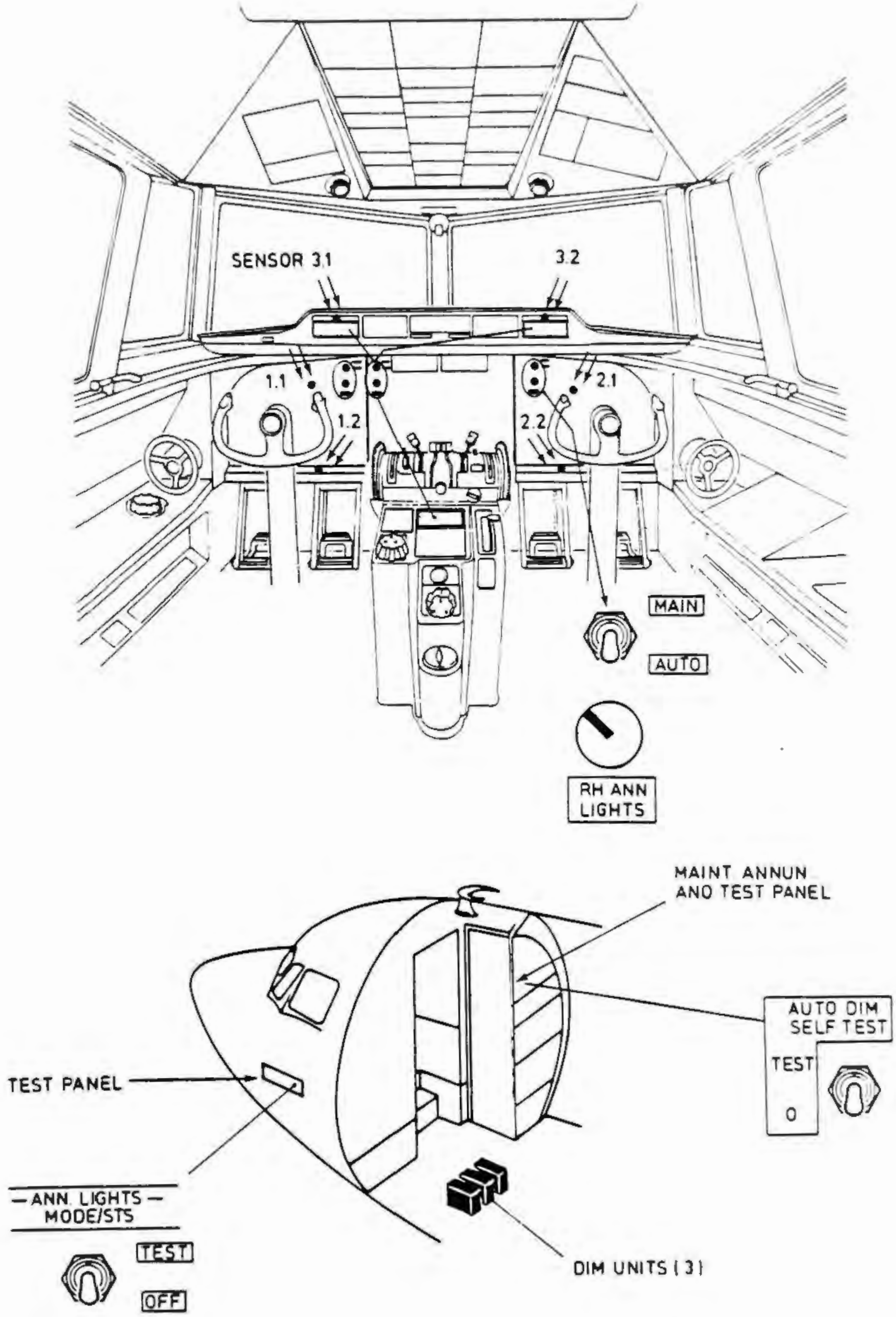
WARNING LIGHTS	MASTER WRNG LT AUTO RESET	MAN DIM	AUTO DIM	MODULES
O.HEAT (generators)				A
INOPERATIVE BOTH (gen 1 and 2)				A
INOP (inverters)				A
O.HEAT (batteries)				A
INOP (alternators)				A
O.HEAT (alternators)				A
GEARBOX (oil press, 2x)	*	*	*	A, B+C
ENG OIL (press, 2x)	*	*	*	A, B+C
ASYMM (flaps)		*		A+B
CAB BLOWER (overheat, 2x)		*		A+B
CAUTION LIGHTS				
SPILL (2x)		*	*	B+C
PNM PR (2x)		*	*	B+C
IGNITION (2x)		*		C
PRESS (cabin, 2x)		*		B
DOOR (large cargo)		*		B
IND LIGHT				
NOSE (2nd down lock)(green)		*		B

MODULE A : Master warning steering/reset module
MODULE B : Dim module
MODULE C : Auto reset and dim steering module

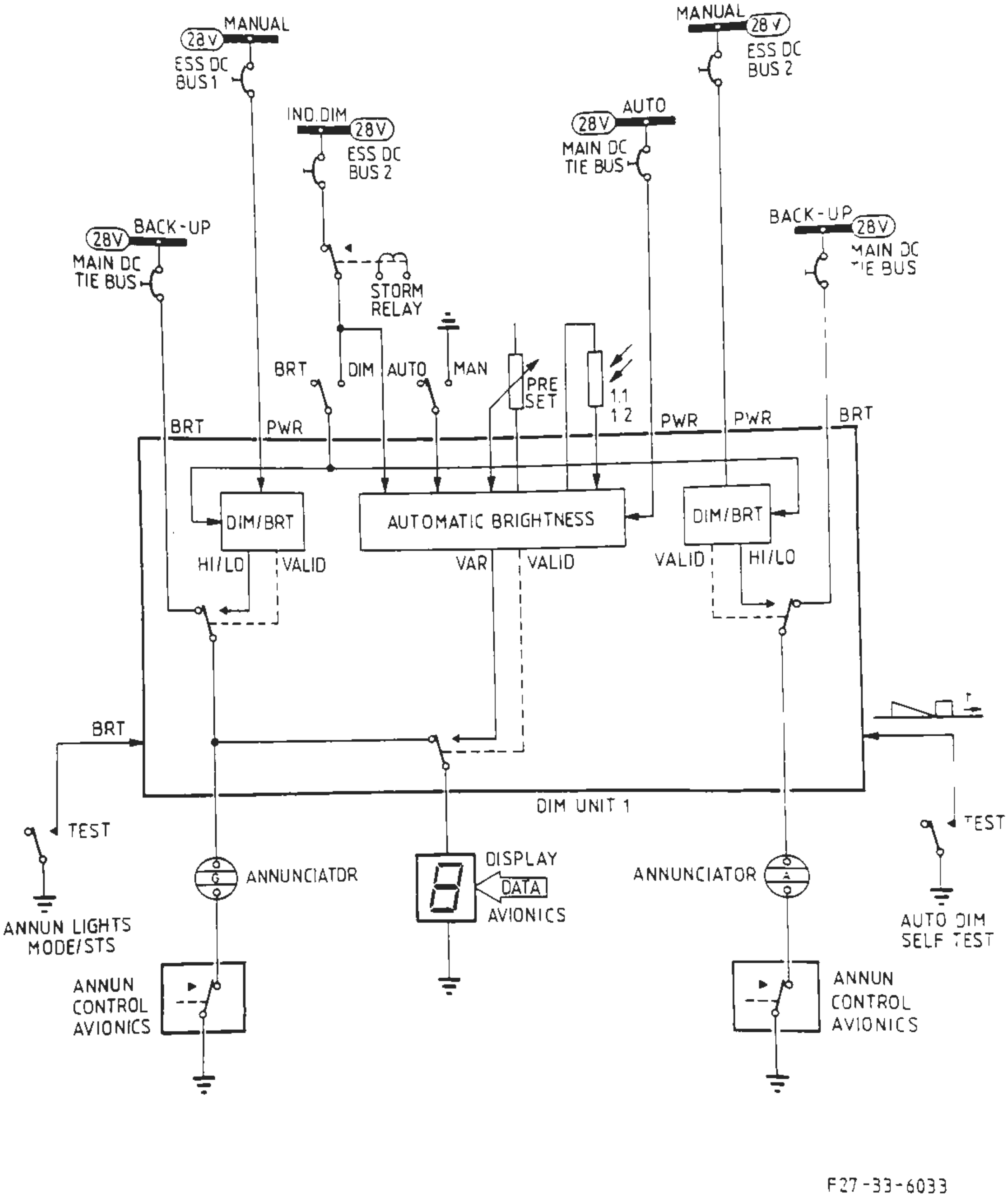
INDICATION LIGHTS



MODULE - INSTALLATION (TYPICAL)



ANNUNCIATORS AND DISPLAYS LIGHTING



ANNUNCIATORS AND DISPLAYS LIGHTING, CIRCUIT

20.0 PASSENGER COMPARTMENT LIGHTING

Lighting is provided for the passenger-, toilet-, entrance- and luggage compartments and passenger reading requirements.
This section includes also the passenger warning and stewardess call system.

20.1 Passenger Compartment Lighting

The main lighting for the cabin consists of one row of fluorescent-type lights throughout the cabin. The lights are covered by translucent, ceiling panels and are controlled by two switches on the stewardess panel. Reading lights, one for every passenger, are incorporated in the passenger service panels located at both sides of the cabin. Each light is activated independently by a switch adjacent to the light.

The lights in the toilet and luggage compartments are switched on by switches located on the stewardess panel.

20.2 Passenger Warning System

When the FASTEN SEATBELTS switch at the overhead panel is set to ON the fasten seatbelts sign and the RETURN TO CABIN sign in the toilet compartment are on while also a low chime signal is produced anytime this switch is changed from position.
The operation of the NO SMOKING switch at the overhead panel is similar but now of course the NO SMOKING signs are illuminated.
The TOILET OCCUPIED sign can either be red or green. The sign changes to red when the toilet door is locked from the inside.

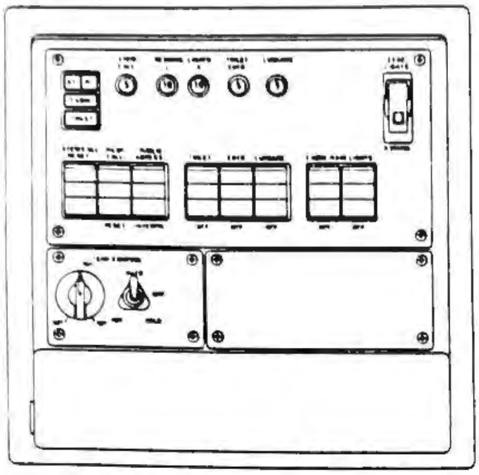
20.3 Stewardess Call System

When the STEW CALL button at the cockpit overhead panel is pressed the amber PI (pilot) light and the amber PILOT light on the stewardess and pantry panel resp. are on. Also a high/low chime signal is heard from the passenger address (PA) loudspeakers. The lights can be switched off when the STEW CALL-RESET switch on the stewardess panel or the RESET button on the pantry panel is pressed.

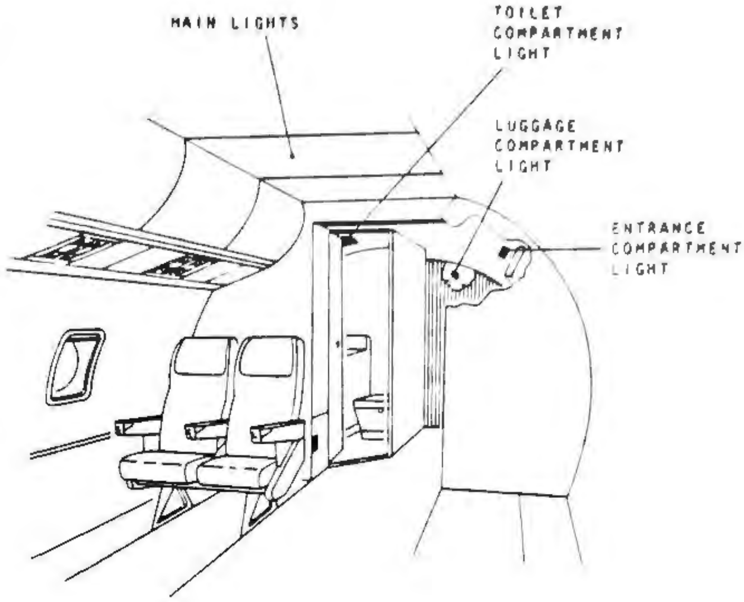
If a passenger operates the stewardess call switch on his service panel or in the toilet compartment, an integral light in the switch is on. The amber CABIN or TOILET lights on the stewardess and pantry panel are on while a high chime signal is heard from the PA loudspeakers. This call sign is reset when the stewardess call switch is reset.

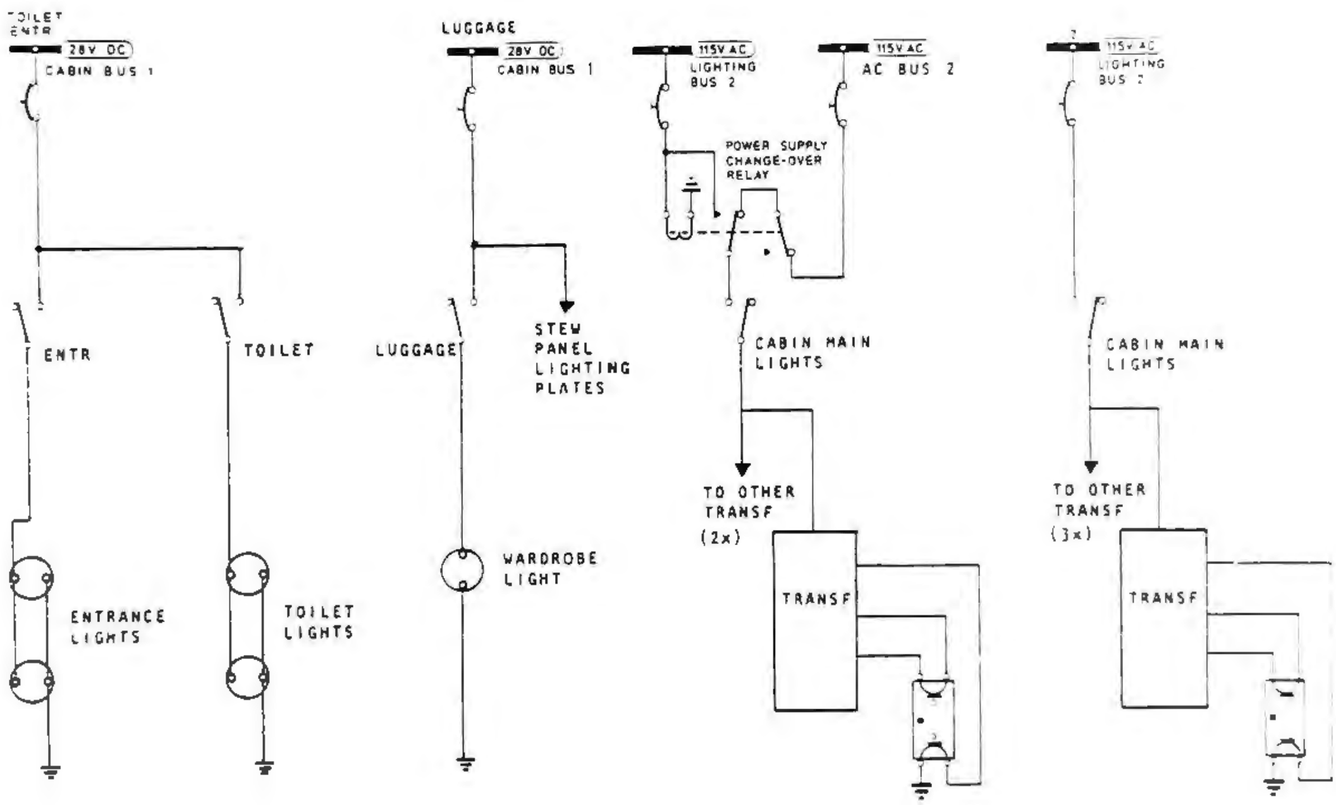
To call the cockpit crew, the stewardess can press the PILOT CALL-RESET switch on the stewardess panel to the mid position. A blue light on the cockpit overhead panel and the amber ST (= stewardess) light on the stewardess panel are on. When the PILOT CALL-RESET switch is pressed to the PILOT CALL position apart from the lights a chime in the cockpit is heard. The system is reset by operating the switch to the RESET position.

END



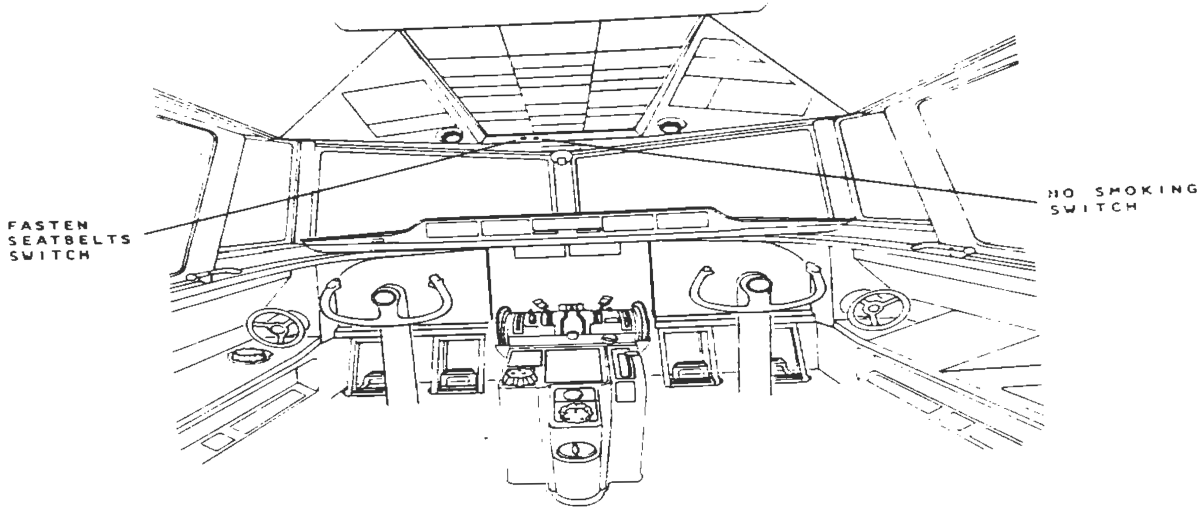
STEWARDESS PANEL

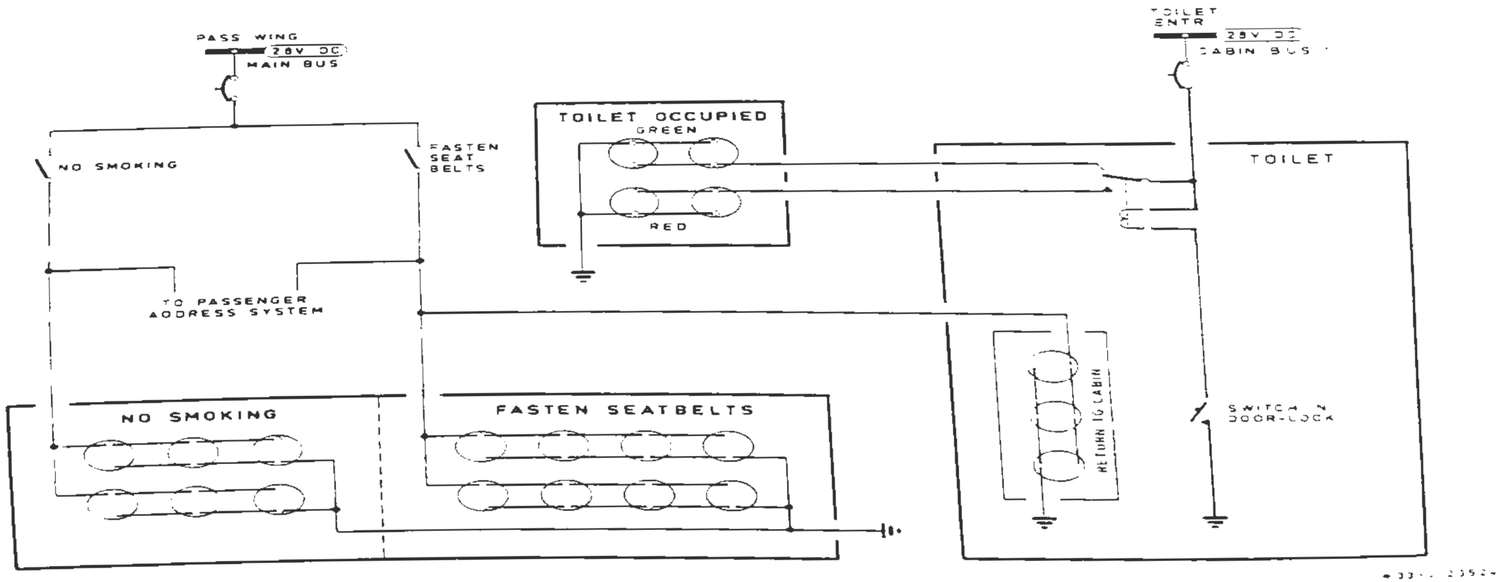




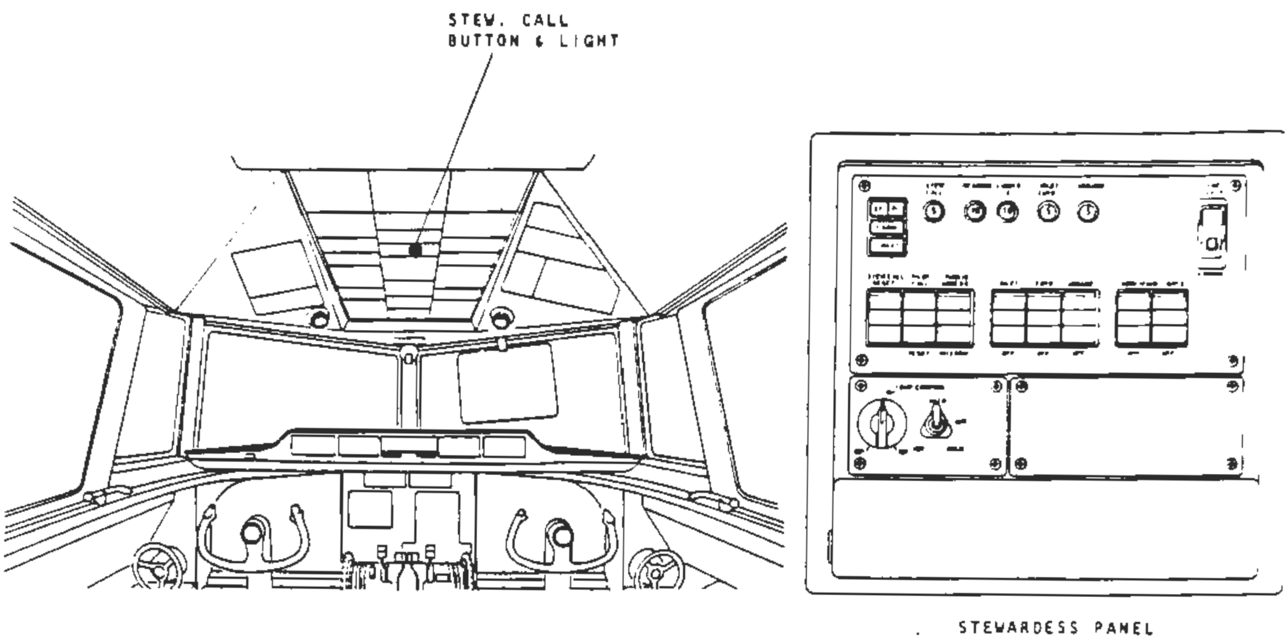
PASSENGERS COMPARTMENT LIGHTING

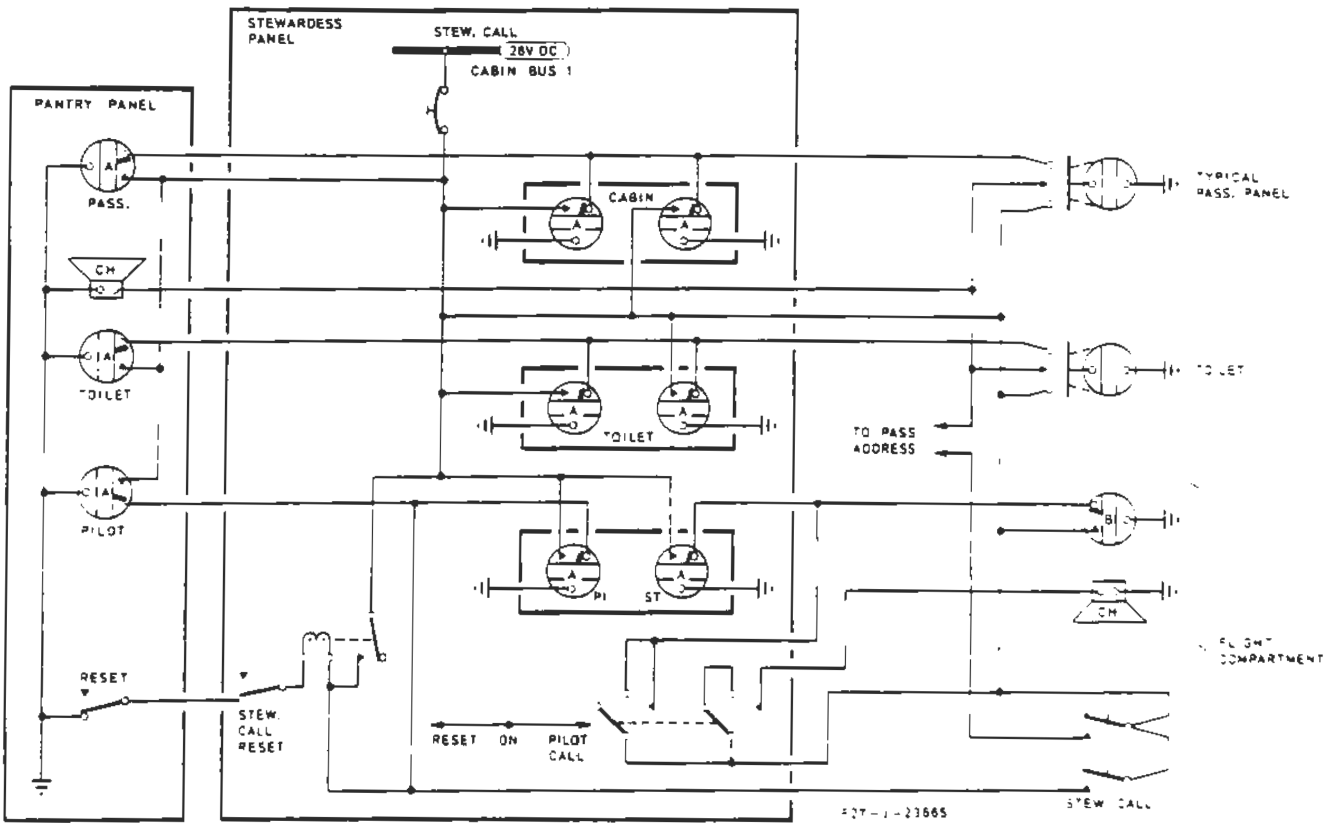
Maintenance Training





PASSENGER WARNING SYSTEM





STEWARDESS CALL SYSTEM

30.0 CARGO AND SERVICE COMPARTMENT LIGHTING

The cargo compartment is illuminated by three dome lights in the centre of the ceiling. The lights are controlled by a switch located in the cockpit entrance or on one of the light assemblies.

Lights for servicing are installed in the nose wheel bay, main wheel bays and air conditioning compartment. A socket for connection of a portable light is situated near the fixed lights. The lights and sockets are supplied via a green-guarded switch on the LH side of the cockpit entrance.
A portable light is stowed in a case in the nose wheel bay.

40.0 EXTERIOR LIGHTS

The exterior lights are controlled from the lower overhead panel.

40.1 Navigation Lights

The navigation lights are installed in both wing tips and at the tail cone.
The lights are directly controlled by the NAVIGATION switch.

40.2 Anti-Collision Light

A rotating anti-collision light with two bulbs is installed on top of the vertical stabilizer.
An electric motor within the light assembly rotates the bulbs at approximately 45 rpm to result in a flashing frequency of 90 flashes/minute. The light is directly controlled by the ANTI COLL switch.

40.3 Strobe Lights (optional)

A flashing strobe light can be installed in each wing tip. Power for these flashing lights is generated by high energy units mounted on circular access panels near the wing tip. The lights are directly controlled by the STROBE switch.

40.4 Wing Ice Inspection Lights

Two wing ice inspection lights are installed in the gearbox access doors. The lights are directly controlled by a WING INSP switch.

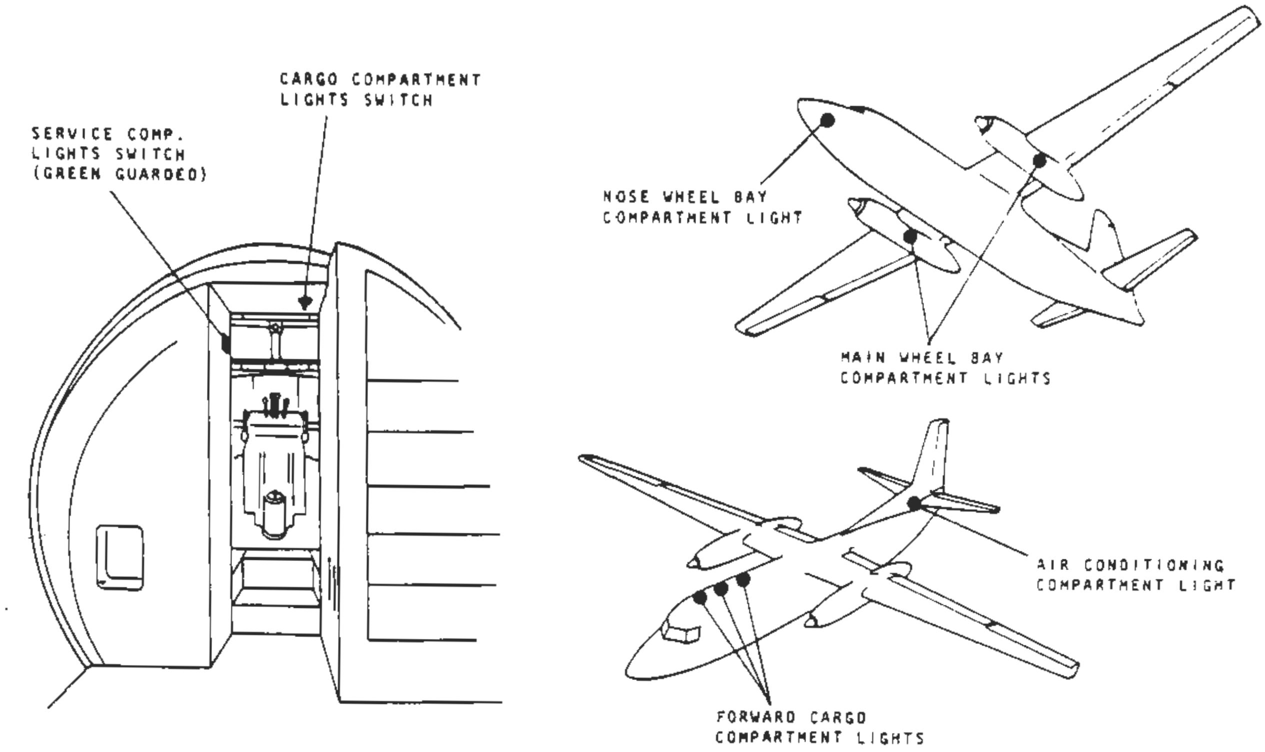
40.5 Landing Lights

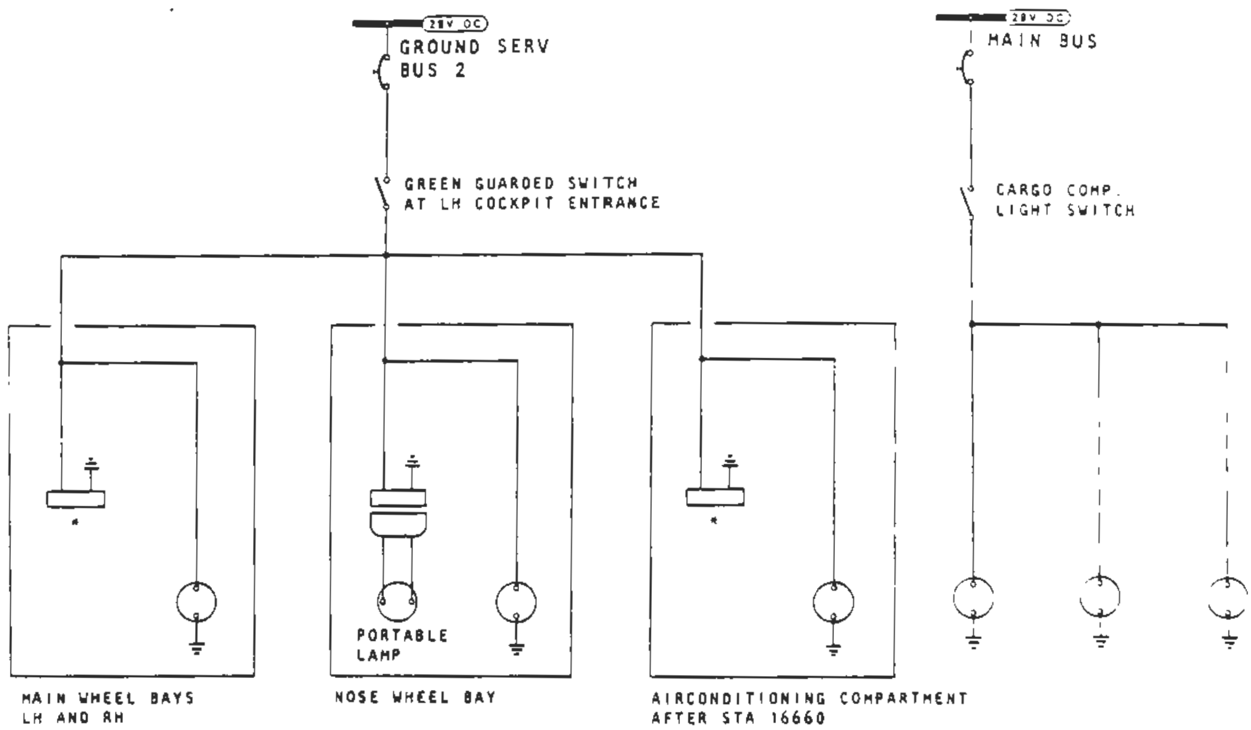
The landing lights are installed in the leading edges of each outer wing. An anti-glare grill, necessary to shield the cockpit from the glare of the light is connected to the front of the light. The lights, 600 Watt each are controlled by the LANDING switches via relays located in the main junction box.

40.6 Taxi Light

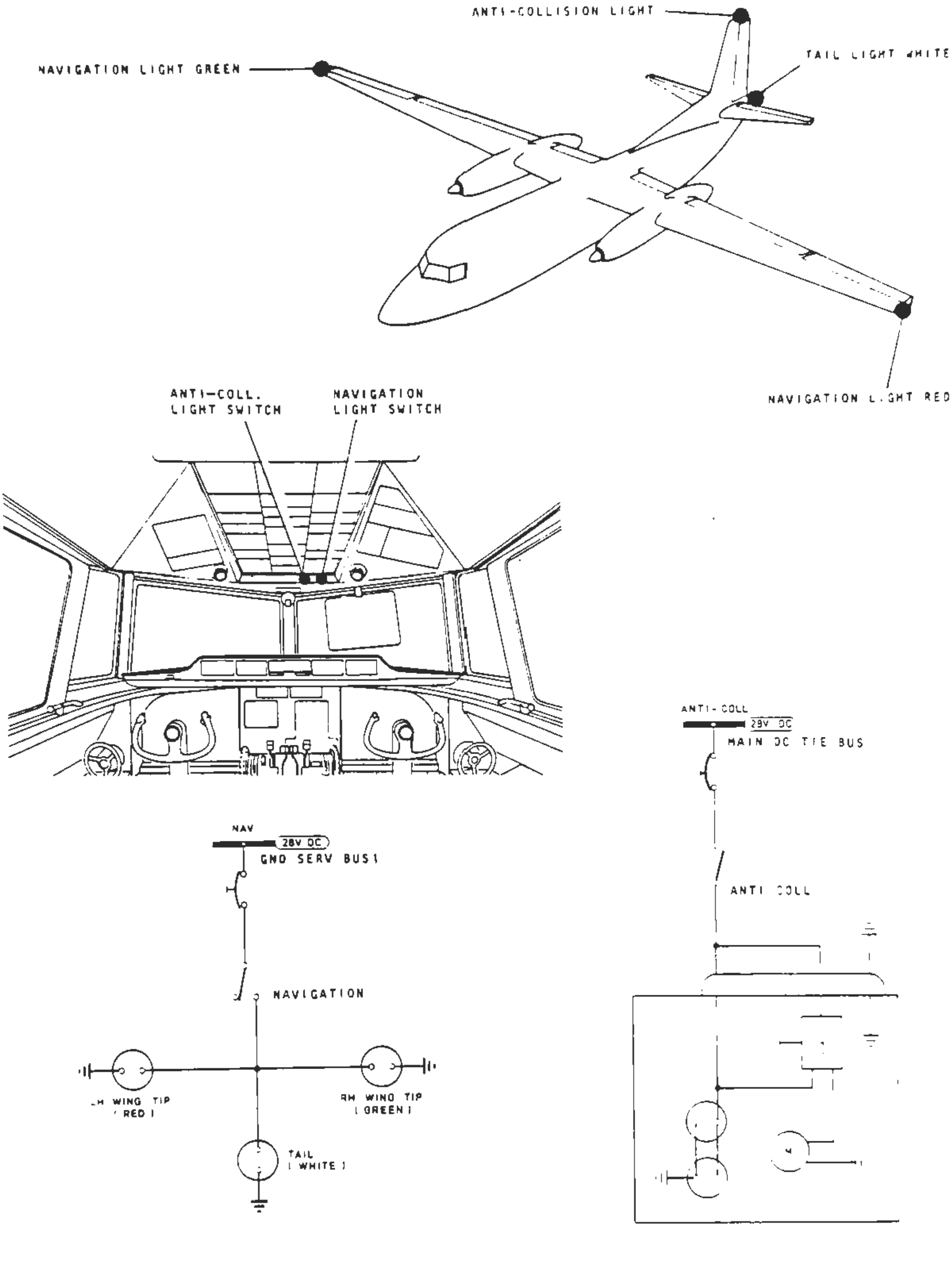
The taxi light is mounted on the nose landing gear structure and is controlled by the TAXI switch via a relay located in the main junction box. When the nose gear is in the up-locked position the relay de-energizes and the taxi light goes off.

END

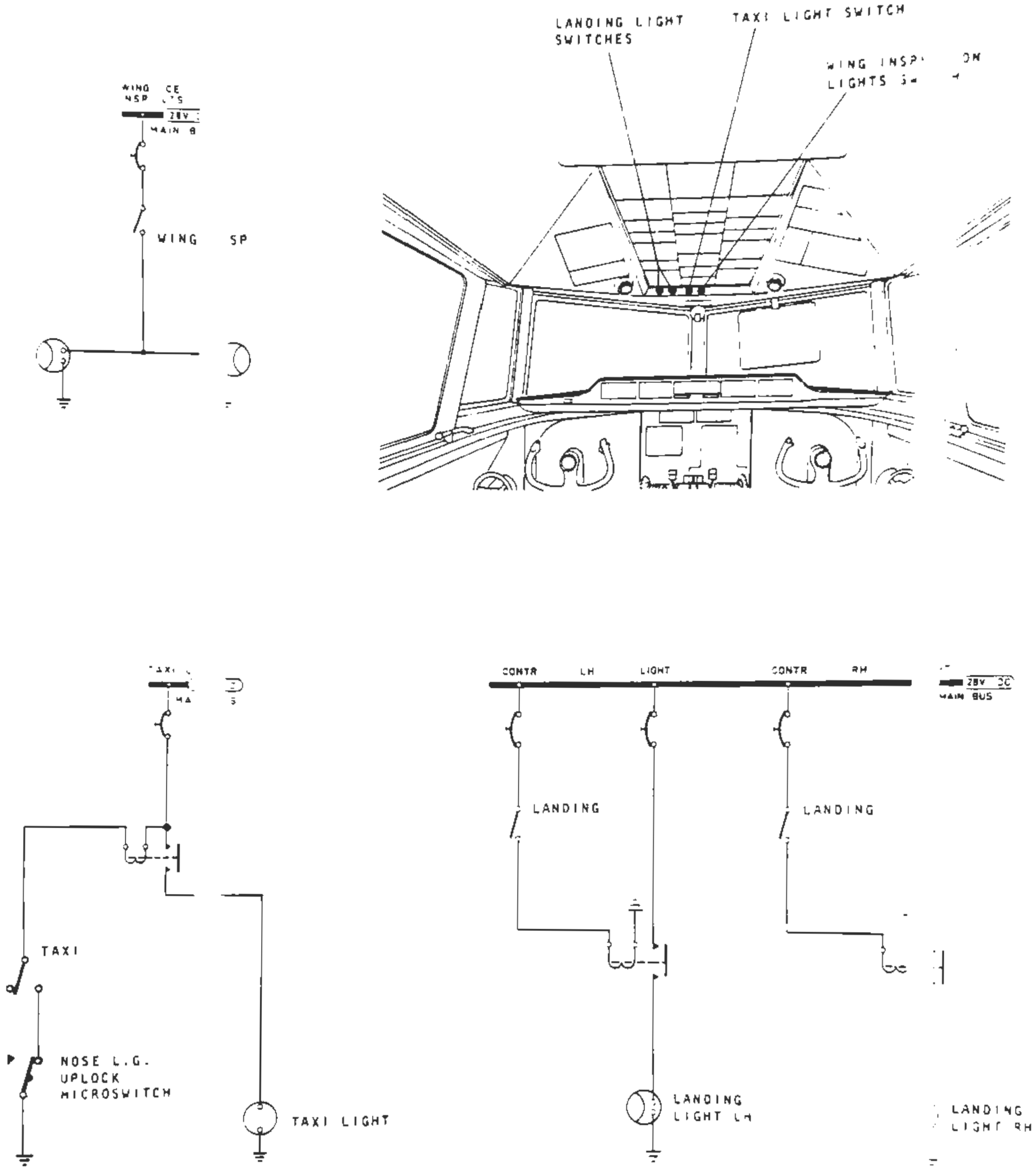




CARGO AND SERVICE COMPARTMENTS LIGHTING



NAVIGATION AND ANTI-COLLISION LIGHTS



NDING, TAXI AND WING INSPECTION LIGHTS

50.0 EMERGENCY/NIGHT AND EVACUATION LIGHTS

The aircraft is equipped with twelve sets of emergency/night lights and evacuation lights. The lights are located in the cabin and toilet compartment.
During flight the emergency/night lights are always on. They provide cabin illumination in case the cabin main lights are inoperative or switched off, for instance during night flights.
During flight the evacuation lights are normally off, they come on automatically when the main and emergency/night lights are off due to a power failure.

The emergency/night and evacuation lights are controlled by the EMERG-EVAC LTS switch on the overhead panel.
An amber "not-armed" light, above the switch is on when the switch is not in the ARMED position. ARMED is the in-flight position.

When the switch is in ARMED:
- the amber light is off,
- the emergency/night lights are on, provided the essential DC bus is energized,
- the evacuation lights are armed i.e. stand-by. They turn on when an electrical power failure occurs. Power for the evacuation lights is then derived from four rechargeable battery power supply units which can supply these lights for approximately 20 minutes. The units are located in the passenger compartment.

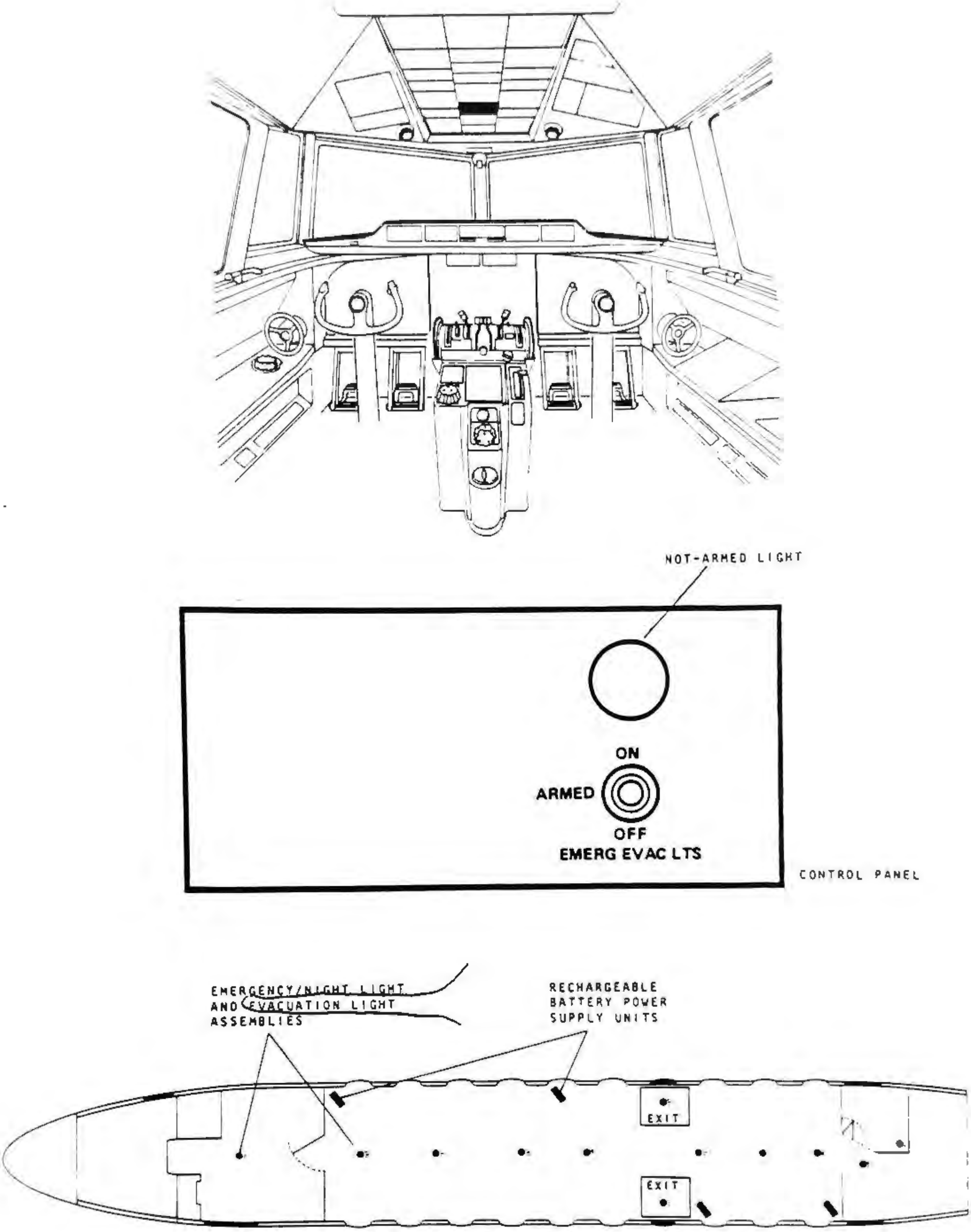
When the switch is in ON:
- the amber light is on to indicate that the switch is in the wrong position,
- the emergency/night lights are on,
- the evacuation lights are on.

When the switch is in OFF:
- the amber light is on,
- the emergency/night lights are off,
- the evacuation lights are off.

Each rechargeable battery power supply contains three batteries, which are charged from the essential DC bus when the EMERG-EVAC LTS switch is in OFF or ARMED. The time to charge empty batteries is approximately 20 hours.

The evacuation lights can also be switched on with the EVAC LIGHTS switch on the stewardess panel, this regardless the switching configuration in the cockpit.
Once switched on from the stewardess panel, switching off goes as follows:
- close the guard of the EVAC LIGHTS switch,
- put the ESSEN PWR switch on the overhead panel momentarilly in on then off.

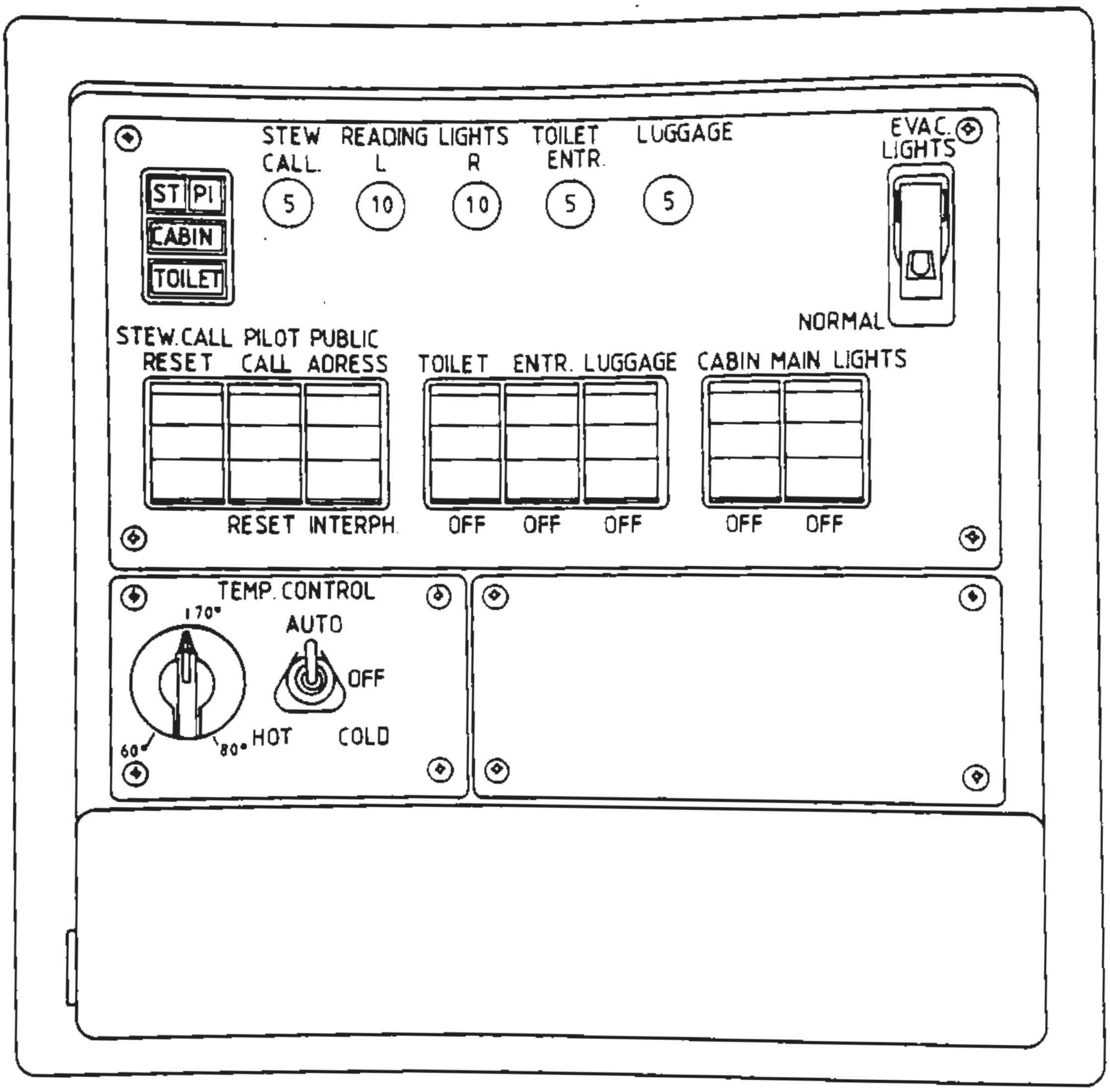
END



EMERGENCY LIGHTS SYSTEM

EMERG EVAC LTS SWITCH	EMERG / NIGHT LIGHTS	EVACUATION LIGHTS	AMBER LIGHT
OFF			
ARMED			
ON			

P/O STEWARDESS PANEL



F27-33-6030

35. OXYGEN

00.0 GENERAL

The cockpit has been equipped with a fixed crew oxygen system and a portable set.

The fixed crew oxygen system mainly comprises an oxygen cylinder, three quick-donning masks and smoke goggles. The cockpit crew uses the system when the cabin pressure is too low due to a faulty pressurization or when there are dangerous fumes or smoke in the cockpit.

The portable set comprises a cylinder, a full-face mask and a cabin attendant's mask. The set allows a crew member to inspect the cargo compartment and/or cockpit while there are dangerous fumes or smoke.

For oxygen systems there are a number of rules and precautions.

WARNING: OXYGEN CAN DEVELOP INTO A POTENTIAL DANGER; THE FOLLOWING PRECAUTIONS MUST BE OBSERVED:

1. Keep oil and grease away from oxygen equipment as an explosive mixture will be formed.
2. Keep oxygen equipment free of organic materials (dust, lint, etc.).
3. When working with oxygen equipment ensure that hands and tools are free of oil and grease.
4. Do not open or close on/off valve quickly.
5. After reinstallation of components check systems for leakage.
6. When working in vicinity of oxygen system ensure that oxygen cylinder on/off valve is closed.
7. Keep fire, hot objects or objects which cause sparks, such as lighters, etc. away from oxygen equipment.
8. Do not refill the cylinders while inside aircraft.
9. Handle oxygen cylinder with care at all times. Do not use cylinder as a support.
10. Keep dust, moisture or foreign matter from cylinder, by capping all open ports and lines.
11. Cap all lines when any system component is removed.
12. Replace, inspect and test cylinder if any rust is found on cylinder walls.
13. If valve cannot be opened by hand wrap with a cloth before applying a wrench.
14. To reduce internal pressure store spare bottles in a cool place, out of direct sunlight. Cylinders containing oxygen should be stored away from cylinders containing other gases.
15. Maintain a measurable pressure (at least 50 psi) inside cylinder to prevent air and moisture ingress.
16. Use only ZX-32 for lubrication and sealing.
17. Clean parts in trichloroethylene, dry with a clean dry air blast and cap all inlets and outlets. Never use carbontetrachloride as this may develop into toxic gases if not fully removed.

10.0 CREW OXYGEN SYSTEM

The system comprises the following components:

- an oxygen cylinder with a shut-off and pressure reducing valve,
- three quick-donning masks, normally stored in boxes located in the RH and LH side panel, the masks are connected to connection boxes,
- rigid piping to interconnect the cylinder and the mask connection boxes.

The cylinder contains 1115 liters (39.4 cu ft) of oxygen when fully charged to 1800 psi at 21 degrees C. The cylinder is secured to the cockpit partition wall behind the co-pilot's seat by means of two strap clamps.

The shut-off and pressure reducing valve shuts off the oxygen supply and reduces the pressure for the masks to 70 $\pm$ 20 psi.
On the valve a pressure gauge gives a reading of the cylinder pressure irrespective of the valve being open or closed.
The cylinder is charged via a non-return charge valve.
A safety disc in the relief valve ruptures when the cylinder pressure exceeds 2800 psi. Via an overboard relief valve all oxygen is then blown overboard.
Quick-release couplings to the shut-off and pressure reducing valve allow quick removal and installation of the oxygen cylinder.

A quick-donning mask incorporates a regulator and a microphone.
The regulator has the following knobs:
- a two-position pressure control knob (NORMAL-EMERGENCY),
- a two-position dilution control knob (DILUTE - 100%). This knob is spring-loaded to the 100% position, however, it is held in the DILUTE position by a trigger mechanism.

The knobs on the mask allow for three modes of operation:

- Diluter demand oxygen flow (supplemental oxygen).
  The pressure control knob is in NORMAL and the dilution control knob in DILUTE.
  In this mode oxygen is mixed with cabin air and delivered on demand. The oxygen-to-air ratio depends on the cabin pressure altitude as follows:

  - 5000 ft cabin alt : 25% oxygen.
  - 20000 ft cabin alt : 50% oxygen.
  - 30000 ft cabin alt and up : 100% oxygen.

- 100% oxygen flow (protective oxygen).
  The pressure control knob is in NORMAL and the trigger was operated, so the dilution control knob is in 100%.
  In this mode 100% oxygen is delivered on demand at all attitude.

- Emergency oxygen flow (protective oxygen).
  The pressure control knob is in EMERGENCY.
  In this mode 100% oxygen is delivered to the operator continuously at a slight overpressure, thus preventing contaminated air to leak inwards at the peak of inhalation. Oxygen consumption in this mode of operation will increase.

30.0 PORTABLE OXYGEN SYSTEM

The system comprises the following components:

- an oxygen cylinder with a shut-off and pressure reducing valve,
- a full face mask,
- a cabin attendant's mask.

The cylinder contains 300 liters of oxygen when fully charged to 1800 psi at 21 degrees C. The cylinder is fitted with a quick-release mounting located at the underframe of the pilot's seat.

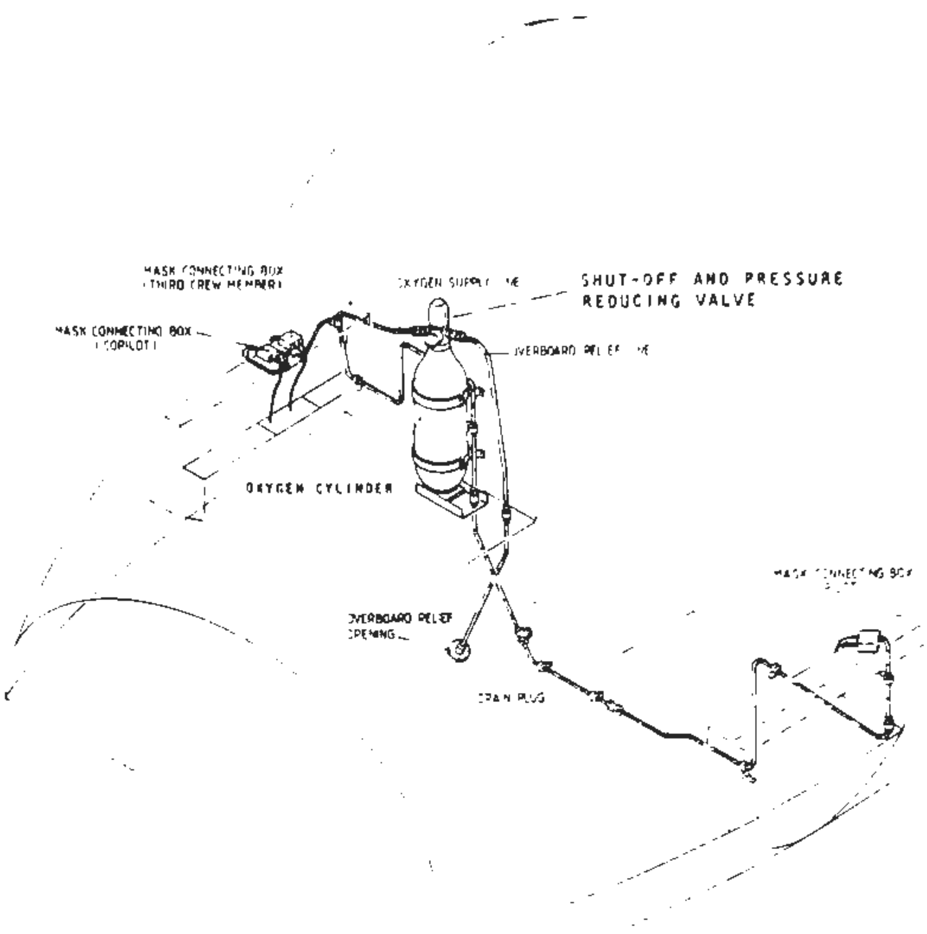
The shut-off and pressure reducing valve shuts off the oxygen supply in the OFF position. In the ON position the supply pressure is reduced to 70 $\pm$ 20 psi. Via two outlets oxygen can flow to the masks, there is a maximum flow of 125 liters/minute for the full face mask and 3 liters/minute for the cabin attendant's mask.
A pressure gauge on the valve gives a reading of the cylinder pressure irrespective of the valve being open or closed.
The cylinder is charged via a non-return charge valve.
A safety disc in the blow-off safety device ruptures when the cylinder pressure exceeds 2800 psi.

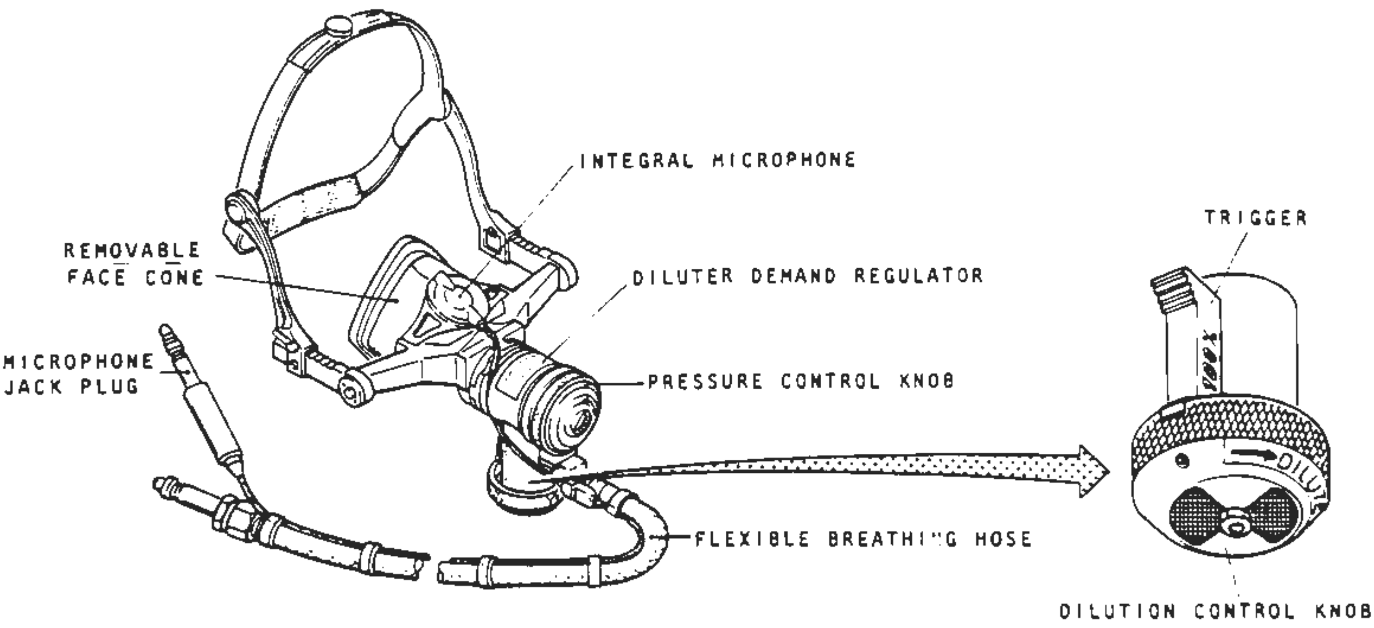
The full face mask has a demand regulator with a purge button, which when pressed, causes a high flow of oxygen into the mask to demist the glass of the mask and to remove smoke in the mask.
The quick-release connector of the full face mask is identical to that of the quick-donning mask.

The cabin attendant's mask is equipped with an economizer bag.

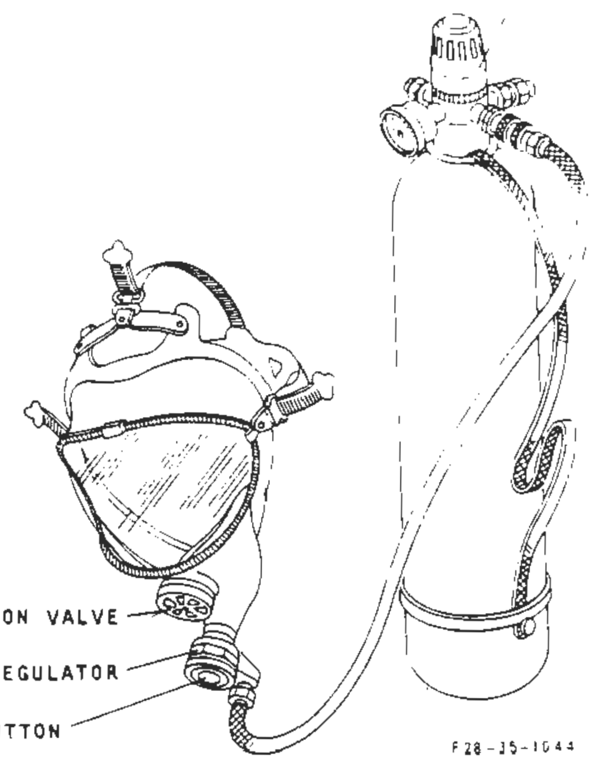
Both masks are stowed in a leather bag attached to the pilot's seat.

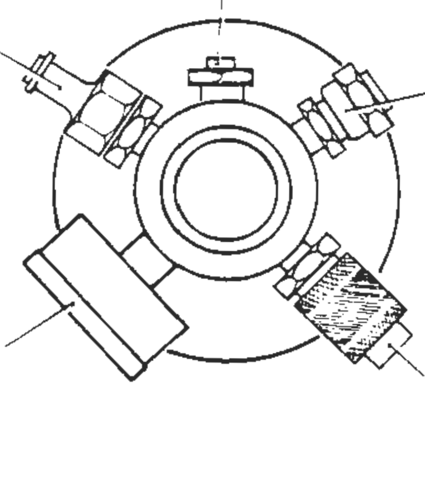
END





LOCATION OF OXYGEN SYSTEM COMPONENTS





PORTABLE OXYGEN CYLINDER

PNEUMATIC

36

36. PNEUMATIC SYSTEM

36. PNEUMATIC SYSTEM

00.0 GENERAL

The pneumatic system can be divided into a normal operating system used to:

a. Extend and retract the landing gear.
b. Operate the wheel brakes.
c. Operate the nose wheel steering.

and an alternate (emergency) operating system which is used to:

a. Extend the landing gear.
b. Operate the wheel brakes.

00.1 Pressure Supply System

Both operating systems are operating at a pressure of 2,900 psi supplied by two identical systems, one installed in each nacelle.
Each of the supply systems comprises:

a. A four stage air compressor installed on the engine-driven gear box. As one air compressor is sufficient for all pressure demands a single compressor or engine failure does not affect the the operation of the pneumatic system. A failure of the air compressor is indicated by a light on the secondary instrument panel.

b. A ground charging valve installed in the nacelle which can be used to charge the pneumatic system or for maintenance purposes. A restrictor prevents excessive pressure surges during charging.

c. A pressure switch, located on the pneumatic panel, to regulate the output pressure of both compressors. When the supply pressure reaches 2,900 psi the drain valves on the oil and water traps are opened (energized).

d. An oil and water trap installed in the nacelle, to extract oil and water delivered by the compressor. This unit is automatically drained via a drain valve which is controlled by a pressure switch.

e. A dehydrator, installed in the nacelle, is charged with alumina to absorb residual moisture in the compressed air. Thus minimizing malfunction of the pneumatic system especially at low temperatures.

Downstream of the dehydrator are installed a cleanable porous metal filter, a pressure relief valve set at 3,500 psi and a non-return valve to prevent failure of one supply system, affecting the other.

After passing through the non-return valve, the two supply systems are joinmed by a T-connection from which a single supply line is routed to a T-connection on the pneumatic panel in order to supply the operating systems.
This panel is located on the left-hand side of the cockpit entrance.

The majority of the pneumatic components used in both operating systems are installed on the pneumatic panel. This panel including all components can be replaced as one unit.

00.2 Normal Operating System

The components on this panel used in the normal operating system are:

A. Two manually operated isolating valves, mechanically interconnected and operated by a rod installed through the side wall of the pneumatic panel.
   One valve is installed in the pressure line just aft of the T-connection in order to isolate the normal operating system from the supply system.
   The other valve is installed to isolate the main storage bottle from the supply systems. The valves are used; during an overnight stop, for maintenance purposes, when a leakage occurs in flight, or to charge the alternate storage bottles only, during an engine run.

B. A main storage bottle is used to store sufficient compressed air to deal with pressure demands during normal operation.
   The air pressure stored in the main bottle is indicated on the main instrument panel.
   To ensure normal system operation the minimum air pressure in this bottle before take-off should be 1,500 psi.
   A drain plug is installed to drain the bottle periodically.

C. An air filter to clean the air from impurities. The filter consists of a felt pad and the filter housing itself can be drained periodically.

After passing the air filter, piping, routes the pressurized air via a pressure reducing valve -reducing the air pressure to 1,000 psi- to the nose wheel steering and the landing gear system.
The air pressure to lower the gear is further reduced to 100 psi by a pressure reducing valve in the down line.

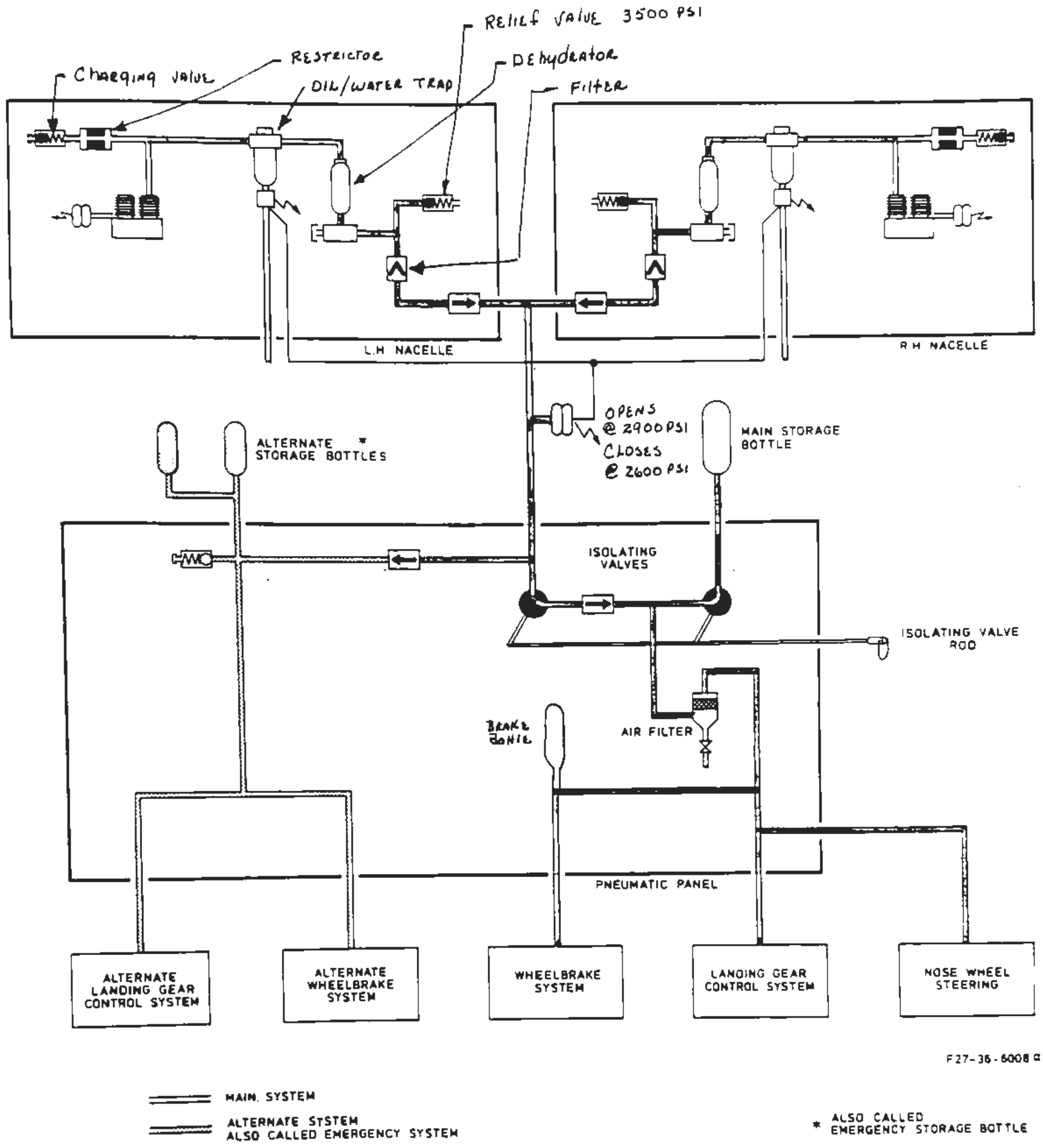
Another piping is routed to the wheel brake system thereby passing a non-return valve, a pressure relief valve (3,500 psi) and a pressure reducing valve reducing the brake pressure to 1,000 psi.
Brake pressure storage bottles installed in the brake supply line ensure sufficient brake pressure for normal brake operation. The pressure in the bottles is displayed on the main instrument panel.
The minimum pressure in these bottles to ensure full brake operation is 1,500 psi before take-off.
A drain plug can be used to drain the bottle periodically.

00.3 Alternate (Emergency) Operating System

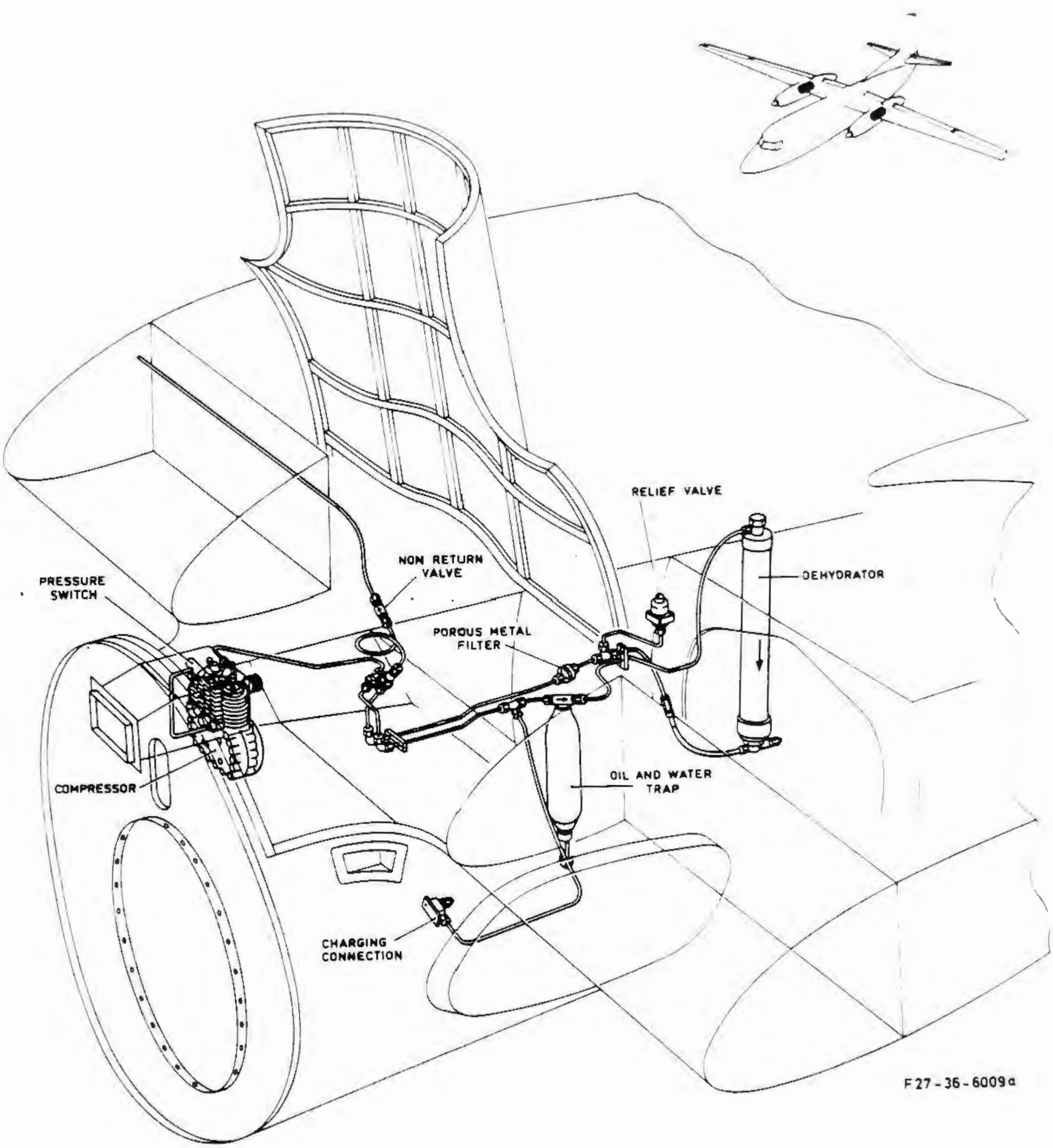
The pressurized air routed to this system passes a non-return valve, a pressure relief valve (set at 3,500 psi) and a pressure reducing valve to reduce the air pressure to 1,000 psi before it is routed to the landing gear down lines (where another pressure reducing valve reduces this pressure to 100 psi) and the wheel brake system.

Alternate storage bottles installed in the alternate supply line ensure sufficient pressurized air to lower the landing gear and to stop the aircraft with the alternate brake system, provided the bottles are charged to 1,750 psi, which should be the minimum pressure in the bottles before take-off. This pressure is indicated in the cockpit on the main instrument panel.
These bottles can also be drained.

END



PNEUMATIC SYSTEM DIAGRAM



PNEUMATIC SYSTEM - NACELLE

10.0 COMPONENTS

10.1 Pneumatic Compressor

The compressor consists of a light alloy crankcase in two halves bolted together. Integral with the front half section is a mounting flange which incorporates an oil feed hole for the compressor lubrication supply. The unit is mounted to the gearbox by adaptors and a clampring.

Mounted above the crankcase are the cylinders which consist of a combined 1st and 2nd stage cylinder and a combined 3rd and 4th stage cylinder next to it. The cylinders are of steel and provided with cooling fins.
Operating inside the cylinders are pistons driven by cranks and connecting rods, which in turn are driven by the drive shaft through spur gears.

A. Cooling

Cooling air is drawn from an intake on the RH side of the upper engine cowling and is fed via a duct to the compressor which is provided with a sheet metal cowling to direct the air around the cylinder fins and also around the intercooler fins for the various stages of compression. The cooling air then escapes at the rear of the gearbox compartment over the wing leading edge. The 4th stage cylinder is oil-cooled.

B. Lubrication

Oil from the engine accessory gearbox is fed to the compressor via the oil inlet on the mounting flange and a gauze filter in the crankcase. The gauze filter is removable for cleaning purposes. The oil is then fed to a metering bus which supplies oil to the crankshaft bearings and via the external oil pipe to the 4th stage piston and cylinder. Splash-fed oil lubricates the 3rd stage from the 4th stage and then drains back to the crankcase. The 1st and 2nd stages are splash-lubricated. The oil then drains away into the crankcase and thence to the pump on the accessory gearbox.

C. Operation of the Compressor

<u>1st stage induction</u>

As the 1st and 2nd stage piston descends, air at atmospheric pressure is drawn past the 1st stage inlet valve via a filter.

<u>1st stage compression and 2nd stage induction</u>

On the upward compression stroke, the 1st stage inlet valve closes and the air is compressed and forced out of the cylinder through the 1st stage outlet valve and intercooler. As this action takes place, an annular space is formed below the rising piston, the compressed air enters this space via the 2nd stage inlet valve.

2nd stage compression and 3rd stage induction

As the piston moves downwards, the 2nd stage inlet valve closes and the air in the annular space is further compressed and forced out of the cylinder via the 2nd stage outlet valve. Here the pressure acts on the pressure switch and at the same time the cooler carries the air to the 3rd stage. As the air reaches the 3rd stage inlet valve the 3rd stage piston is moving upwards and the charge enters the annular space so formed between the two sets of piston rings.

3rd stage compression and 4th stage induction

The 3rd stage piston moves downwards closing the inlet valve and further compressing the air in the annular space. The air then passes out of the 3rd stage outlet, through the cooler assembly and inlet valve, and into the 4th stage cylinder, the piston of which is on the induction stroke.

4th stage compression and delivery

As the 4th stage piston commences its compression stroke, the pressure closes the inlet valve, and the air is further compressed and forced out of the cylinder via the 4th stage outlet valve. This air then flows out of the compressor into the pneumatic system.

10.2 Compressor Failure Indication

A pneumatically operated pressure switch connected to the second stage outlet of each compressor illuminates an amber light on the main instrument panel placarded PNM PR in case the outlet pressure of the second stage drops below a predetermined level. The switch is fitted on the cowling of the compressor.
The light is automatically dimmed when the isolating relay is energized (see propeller system).

10.3 Oil and Water Trap (Nacelles)

When air under pressure from the system enters the inlet connection it passes through the inlet stack pipe and the restrictor and impinges on the baffle. Oil and water deposited on the baffle drains into the base of the trap, and the air flows through the outlet stack pipe to the aircraft pneumatic system. The provision of stack pipes prevents the deposit from entering the aircraft system. A drain valve at the bottom of the unit facilitates automatic draining whenever the system pressure reaches 2,900 psi sensed by the pressure switch on the pneumatic panel.

10.4 Drain Valve (Nacelles)

The drain valve is solenoid operated and incorporates a heater element. Electrical power to the element is controlled by a temperature switch in the RH nacelle.
The switch closes when the ambient temperature is below 4.5 degrees C and opens when the temperature is higher than 10 degrees C.

10.5 **Dehydrator (Nacelles)**

The unit consists of a cylindrical body housing a removable canister charged with activated alumina. The open end of the body, which carries the outlet connector, is threaded to receive an end cap secured by a ring nut. A plate filter is situated in the end cap, secured by a circlip. It prevents small particles of the charge passing into the system. The outlet connector incorporates a discharge valve to facilitate depressurization of the unit before the removal of the charge.

10.6 **Porous Metal Filter (Nacelles)**

This unit consists of a cone shaped porous metal filter enclosed within a filter body and an inlet connection, and clamped together by three bolts.

An arrow on an attached plate indicates the direction of flow.

10.7 **Pressure Relief Valves (Nacelles)**

As the air pressure builds up in the base, the valve seat and guide assembly are forced upwards against the load of the main spring. Simultaneously the small spring causes the valve to follow, thus keeping the valve closed. As the predetermined pressure is reached, the valve is arrested in its movement by its flange coning into contact with the washer. Further increase in pressure and consequent continuation of the upward movement of the valve guide assembly withdraws the valve seat from the valve. Air pressure then dissipates through the drilling in the valve guide and the exhaust drillings in the housing to ambient.

As the pressure drops, the main spring overcomes the smaller air pressure exerted on the valve seat and the valve closes.

10.8 **Charging Connection (Nacelles)**

To protect the system from too high a temperature or pressure rise, due to excessive charging rates, a restrictor is mounted between the charging valve and the line in the connection mounting body.

10.9 **Pressure Switch (Pneumatic Compartment)**

The pressure switch controls both drain valves. When the system supply pressure reaches 2,900 psi both drain valves are energized.
When supply pressure drops to 2,500 psi the switch opens and the drain valves close.
The electrical circuit controlling the solenoid operated drain valves includes a relay between the pressure switch and the drain valve to prevent the valves energizing until the compressors are operating, sensed by the compressor low pressure switch.

10.10 **Isolating Valve (Pneumatic Compartment)**

With the valve operating lever in the OFF position the bottom valve sleeve, under the influence of the spring-loading is held against the

seat at the root end of the top valve sleeve extension, and inlet pressure cannot be transmitted through the valve. Upon actuation of the lever from the OFF to the ON position, the camshaft is rotated, the spring-loaded locking roller rides out of its groove in the camshaft, the central cam portion forces the cam follower down, which in turn moves the valve stem downwards.
The valve stem moves the bottom valve sleeve away from its seat. Air then passes through the drillings in the top valve sleeve to the outlet connection.
On the final movement of the hand lever the roller drops into the second axial groove in the camshaft to spring-lock it in that position.

Valves CLOSED means that the operating rod protrudes from the side panel. When the operating rod is flush with the side panel the valves are OPEN. The operating rod is locked in both positions.

10.11 Pressure Storage Bottles (Pneumatic Compartment)

The main storage bottle is mounted in the pneumatic compartment.
The bottle is of steel construction and has a capacity of 750 cu. in.
The lower fitting is provided with two connections and a drain plug.
Stack pipes prevent moisture, accumulated in the lower part of the bottle, entering the system. Any residue may be drained by unscrewing the drain plug in the fitting. (The alternate (emergency) and brake storage bottles are identical but smaller in capacity).

10.12 Air Filter (Pneumatic Compartment)

The filter is located on the pneumatic panel and is provided to filter out possible scale and dust from the air supplied from the bottle.

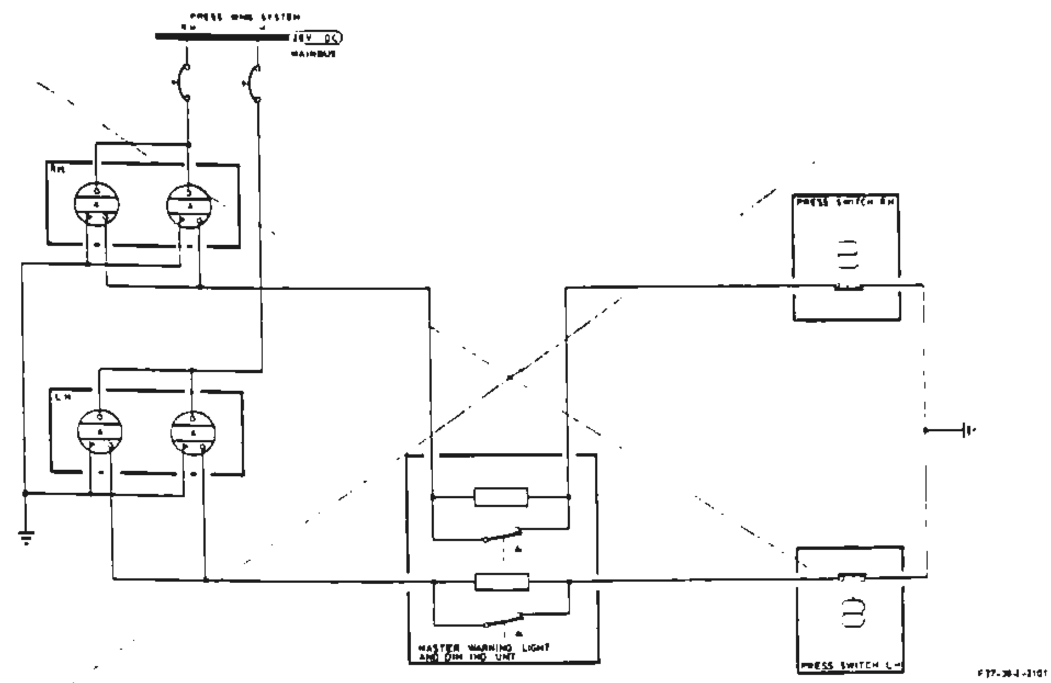
The filter has a hollow cylindrical body with an inlet connection screwed into its side and a drain-plug with lock nut screwed into the bottom.

A filter element, consisting of a felt pad sandwiched between two perforated plates, is housed in the body.

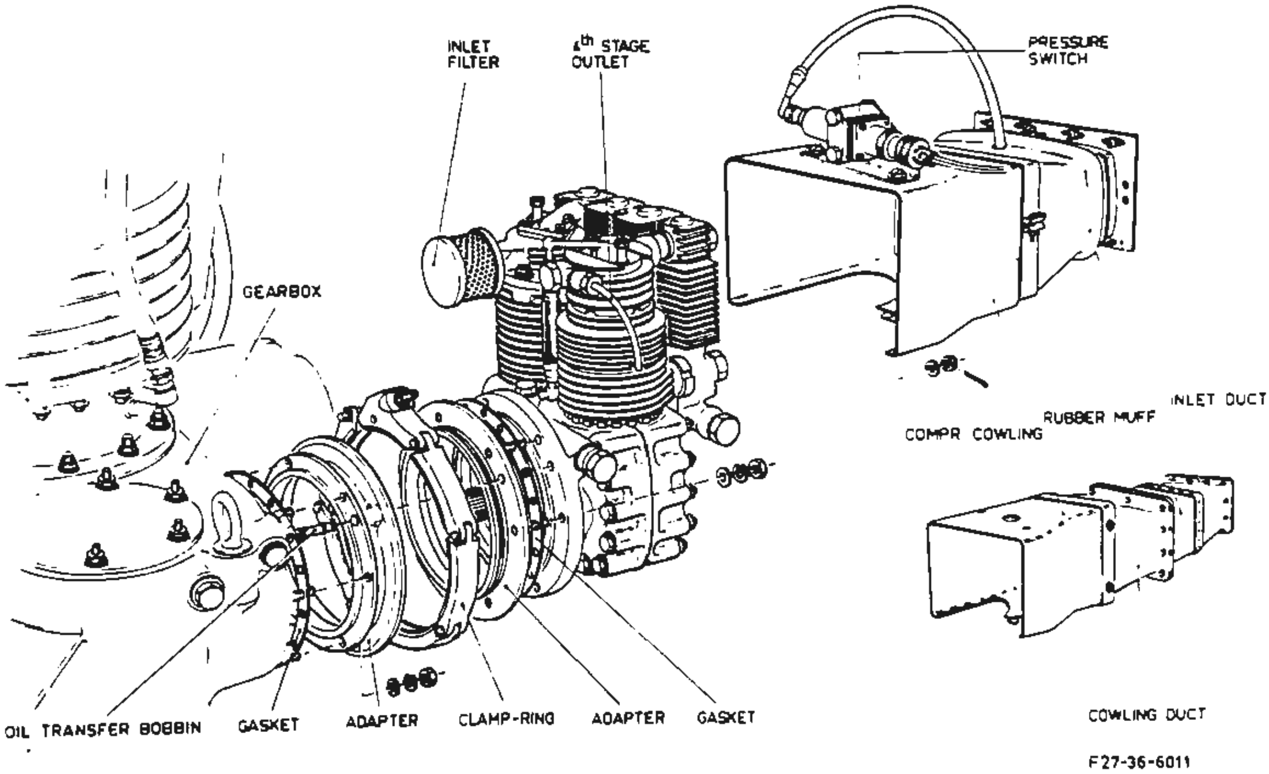
10.13 Piping

Rigid pipes with A.G.S. type connectors are used throughout the system.
Swivel couplings are used on the landing gear to ensure a positive supply between the rigid and the moving parts of the landing gear.
"Aeroquip" flexible hoses for the gauge lines are used between the cockpit floor and the instrument panel.

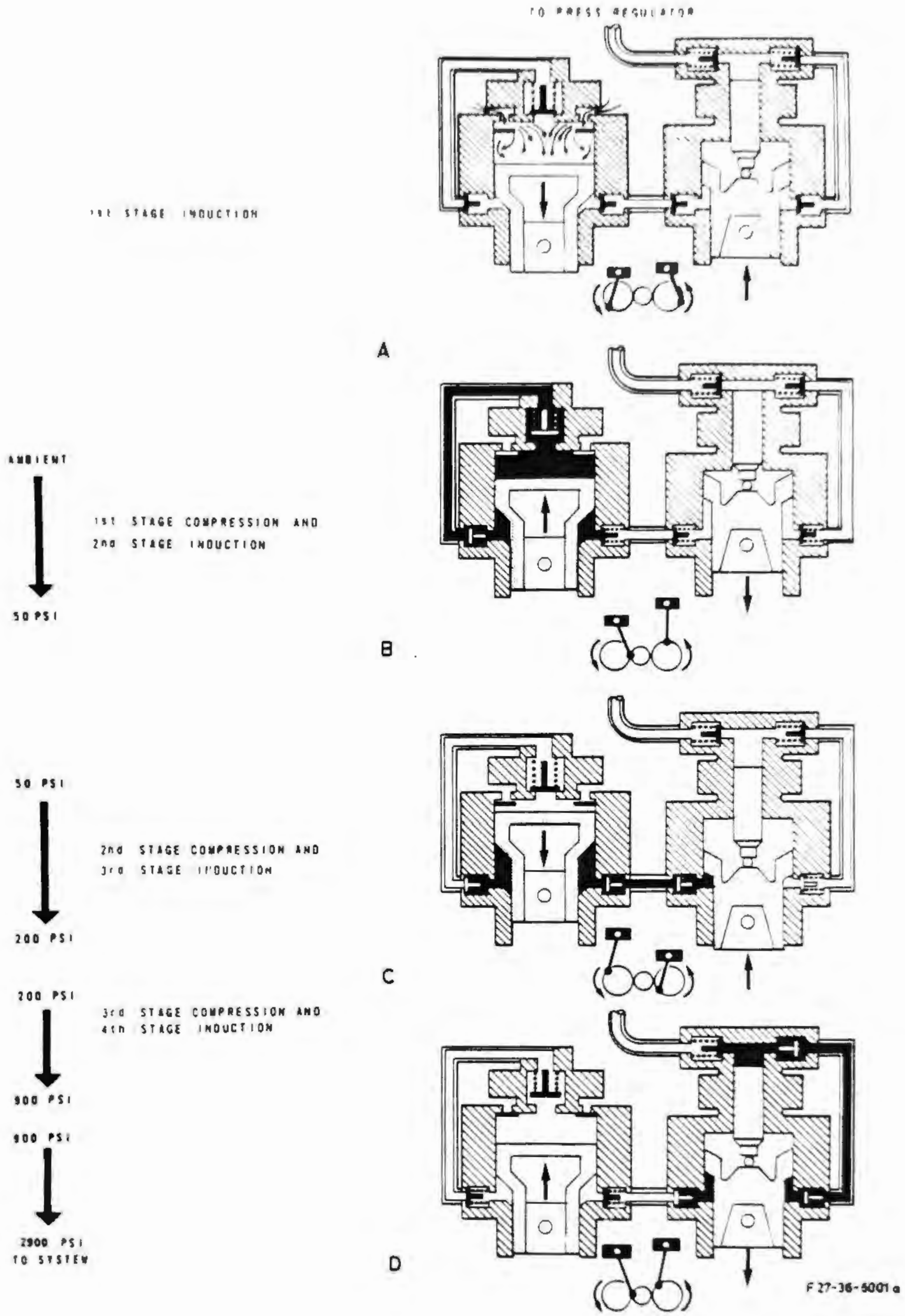
END



COMPRESSOR FAILURE INDICATION SYSTEM

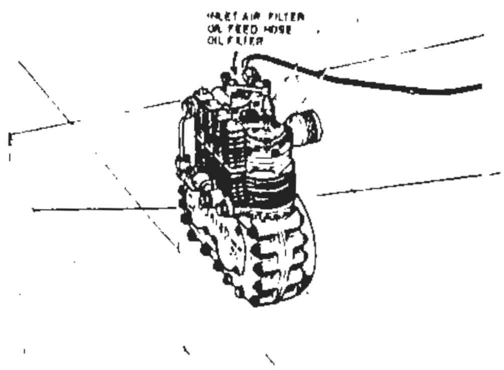


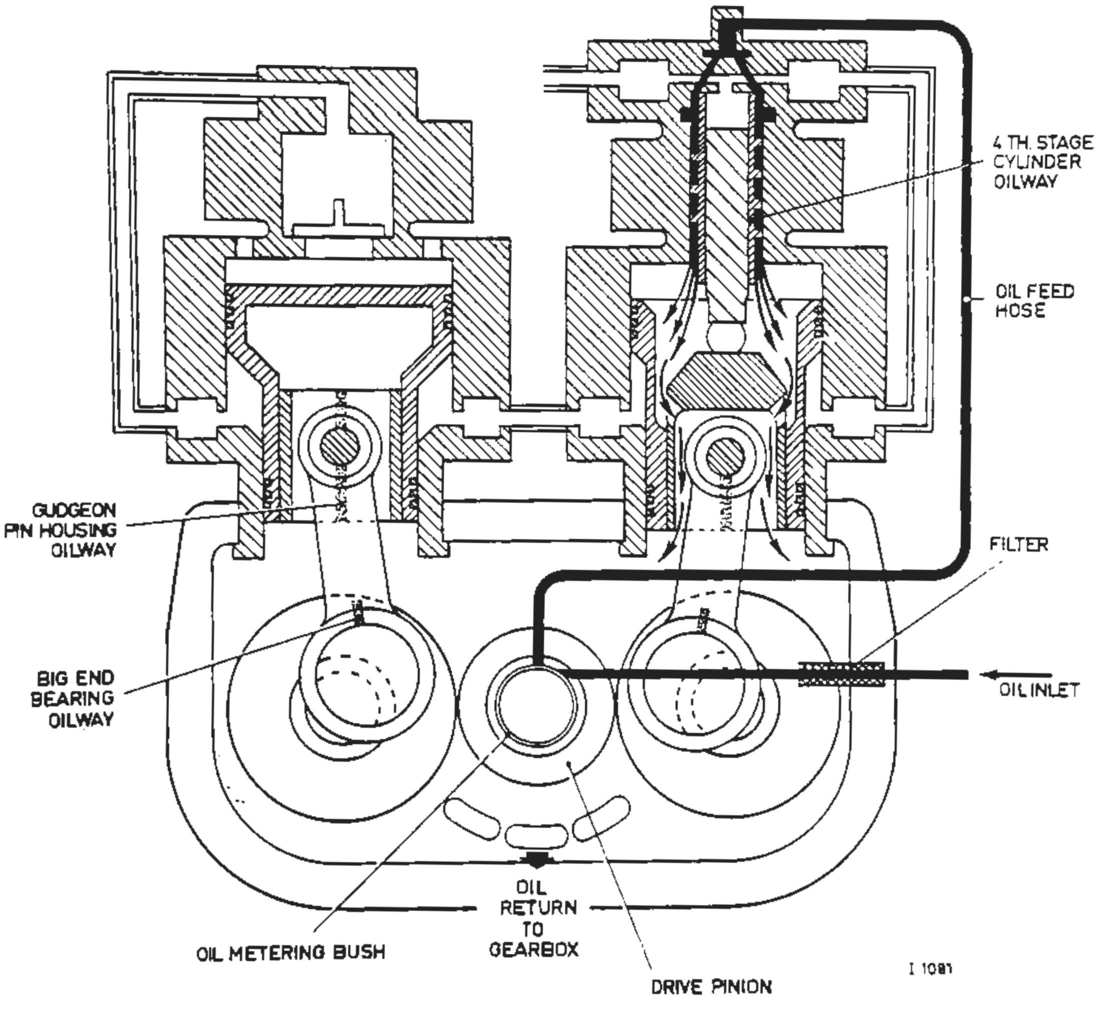
EXPLODED VIEW OF PNEUMATIC COMPRESSOR INSTALLATION



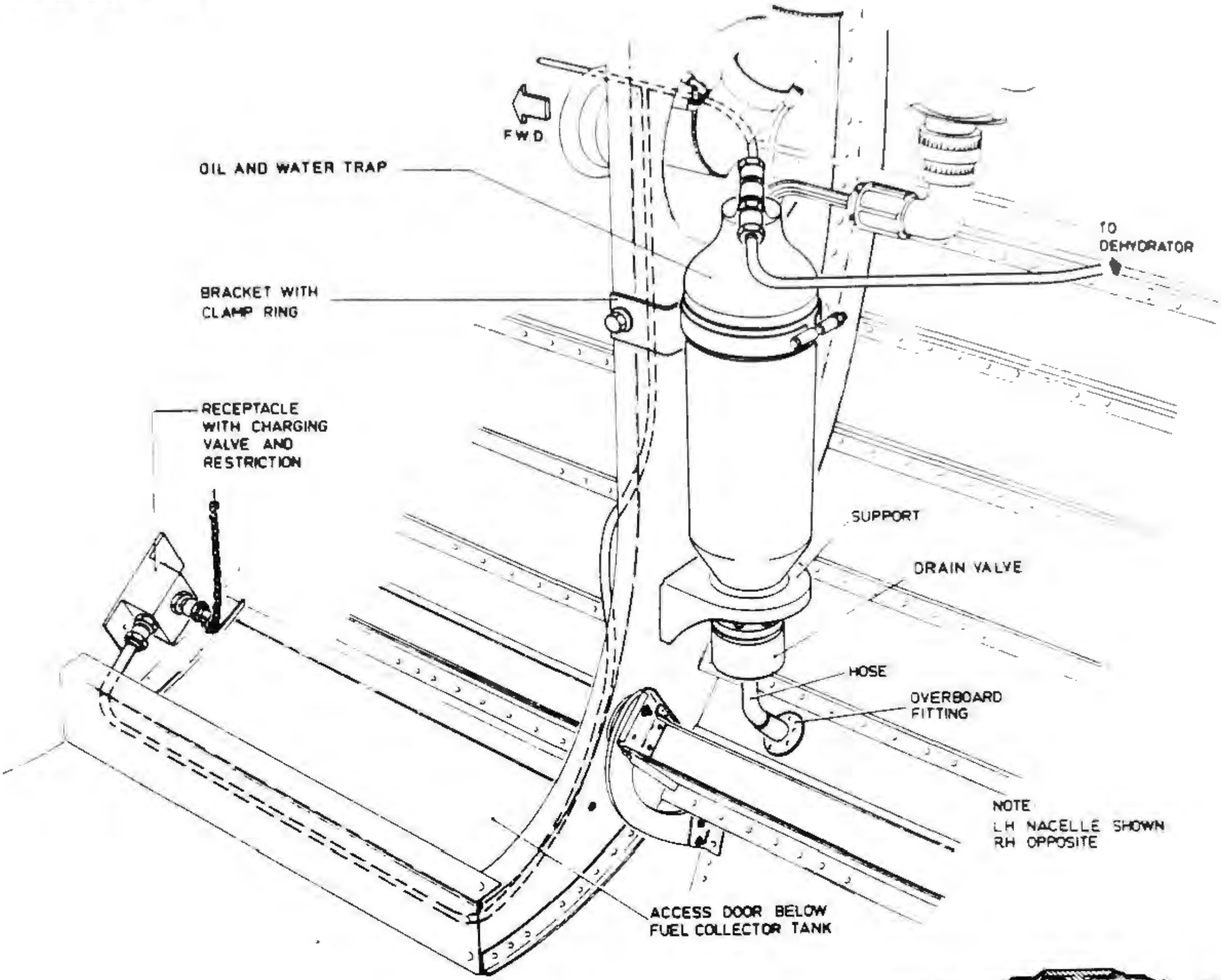
PNEUMATIC COMPRESSOR - FUNCTIONAL DIAGRAM

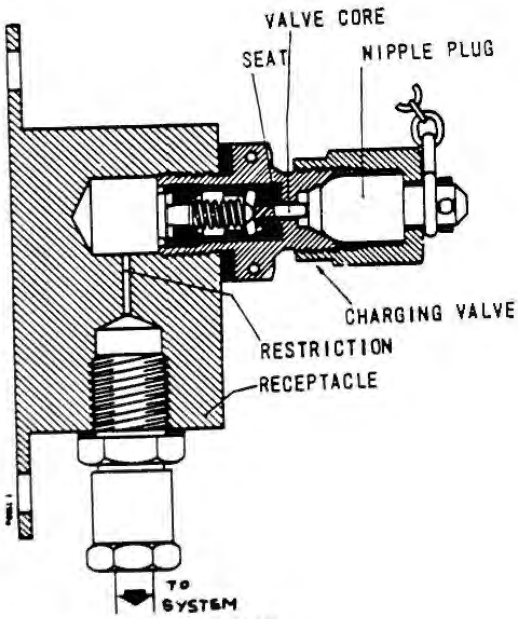
COMPRESSOR



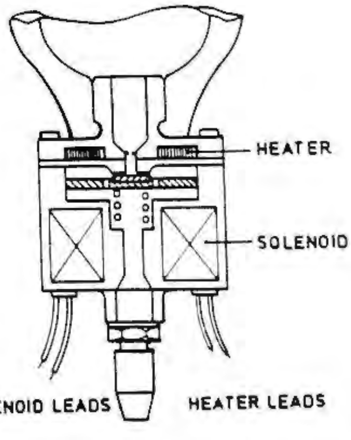


PNEUMATIC COMPRESSOR - LUBRICATION SYSTEM





GROUND CHARGING VALVE



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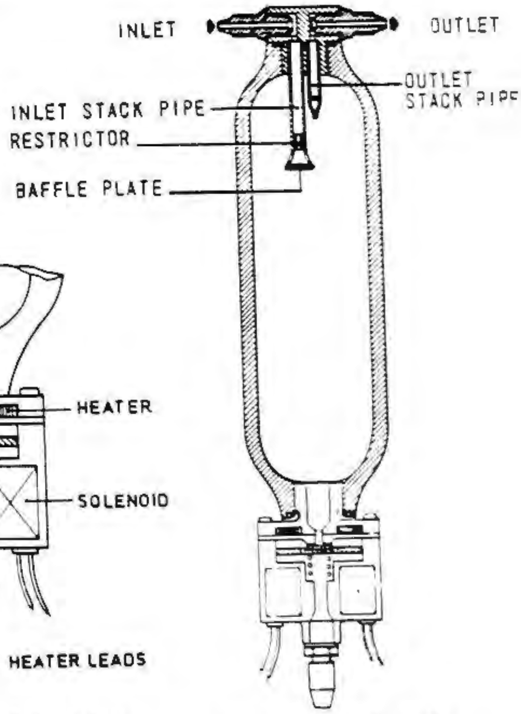
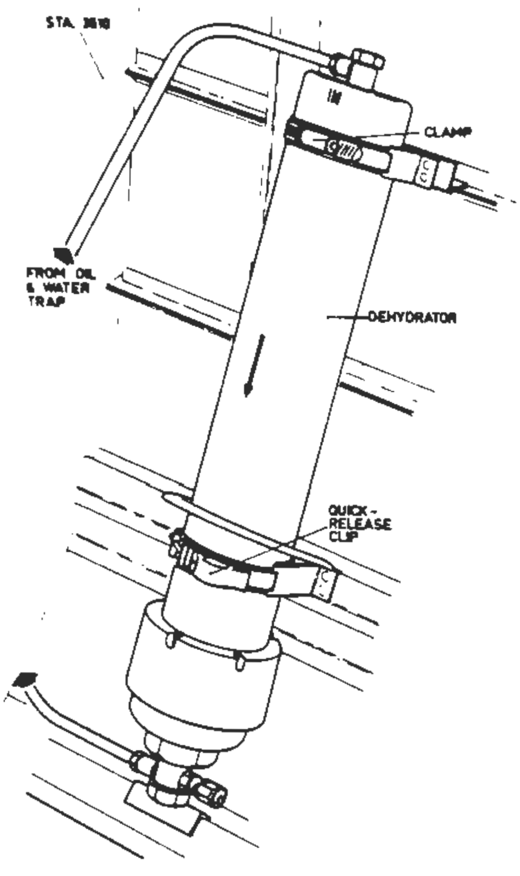
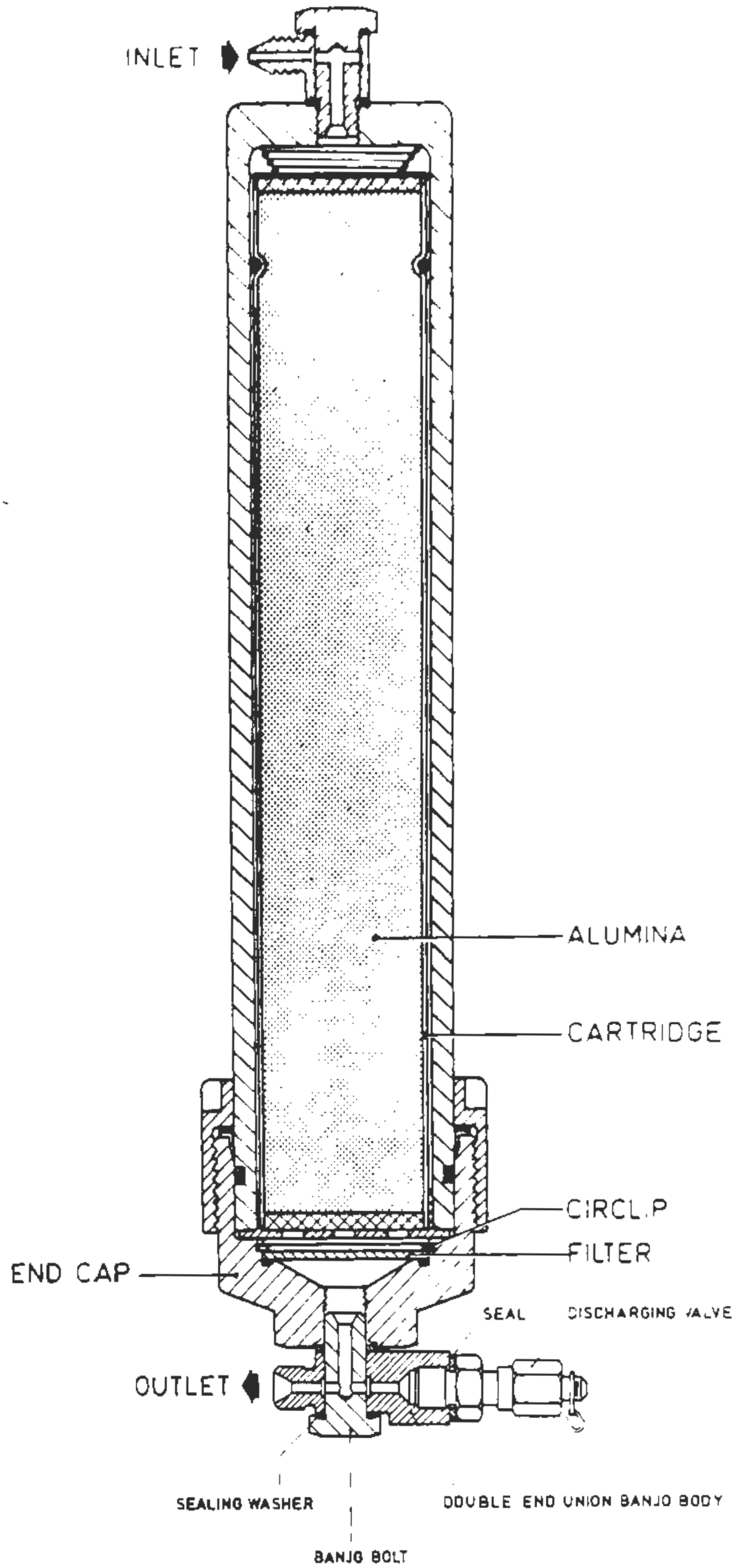


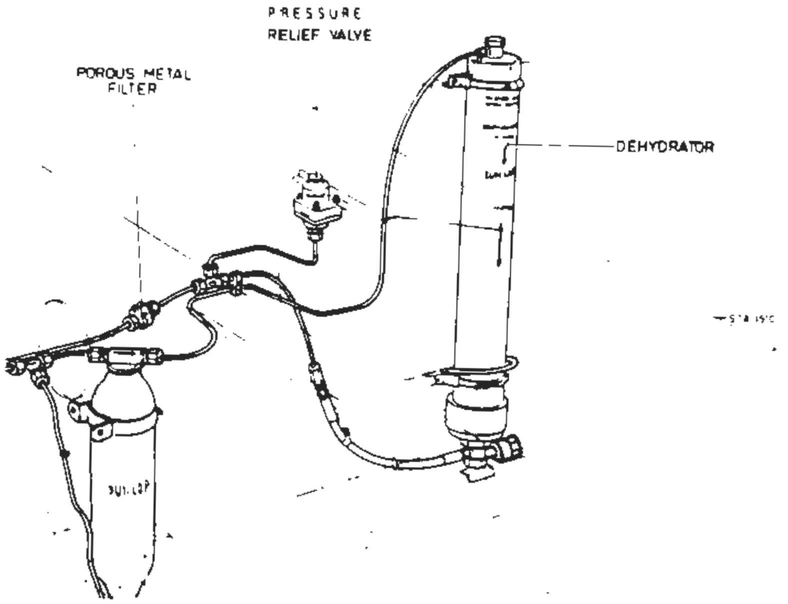
OIL AND WATER TRAP

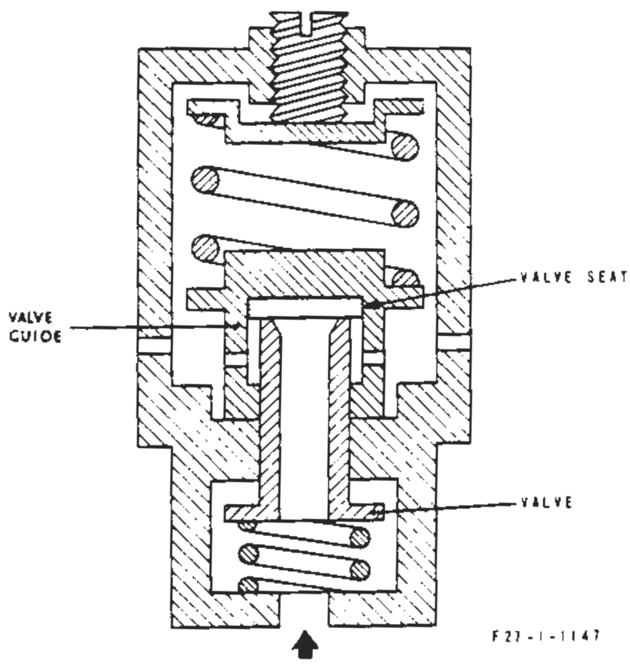
PNEUMATIC SYSTEM COMPONENTS


CLAMP
FROM OIL & WATER TRAP
DEHYDRATOR
QUICK-RELEASE CLIP

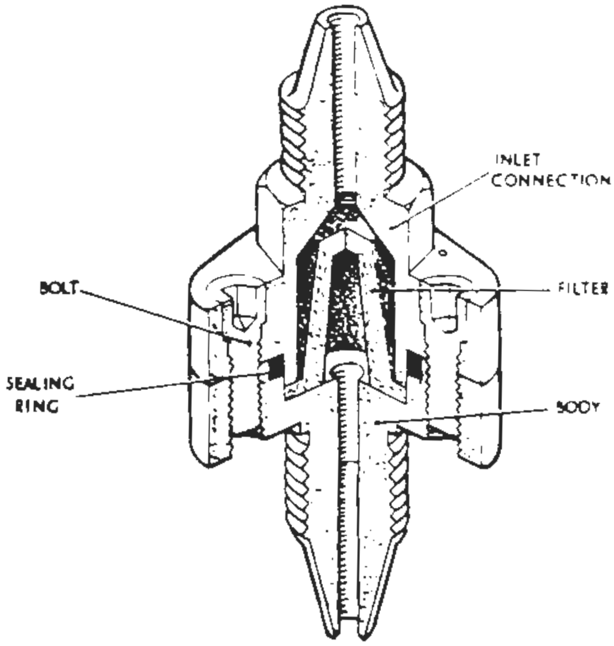

INLET
ALUMINA
CARTRIDGE
CIRCLIP
FILTER
END CAP
SEAL
DISCHARGING VALVE
OUTLET
SEALING WASHER
DOUBLE END UNION BANJO BODY
BANJO BOLT

DEHYDRATOR



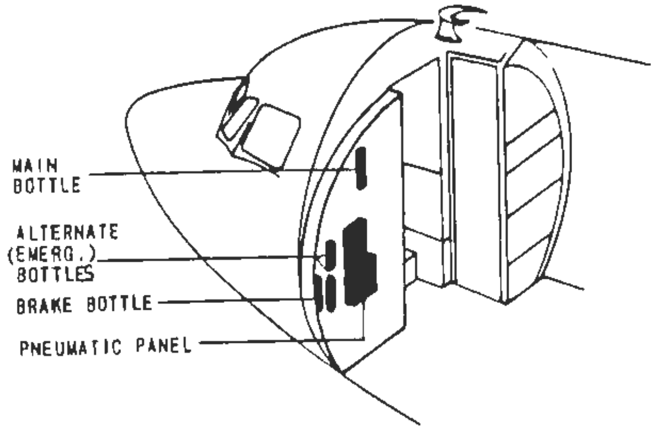


PRESSURE RELIEF VALVE

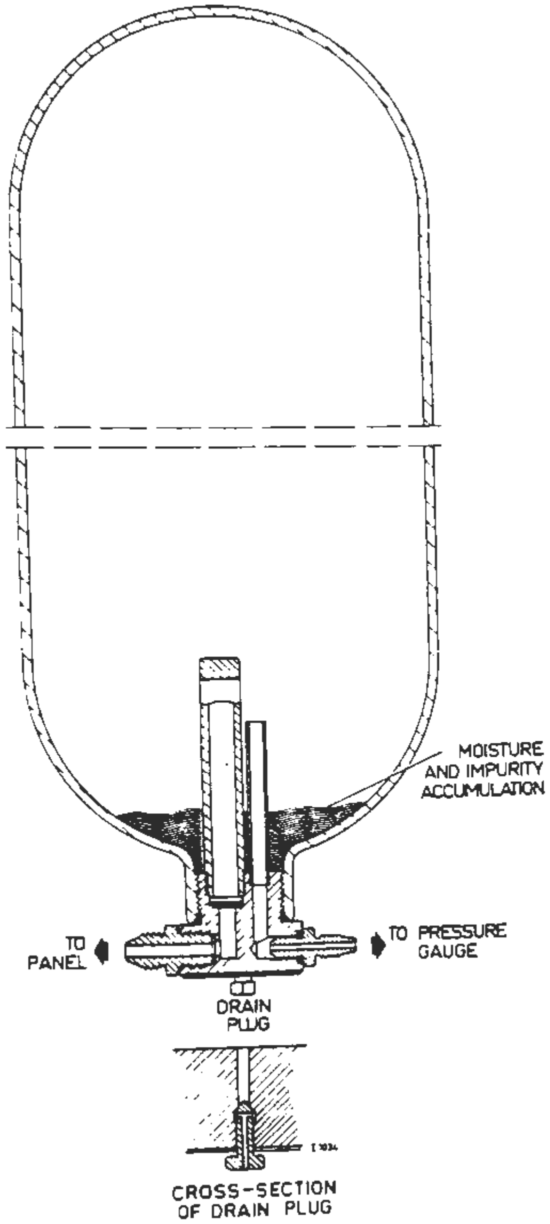


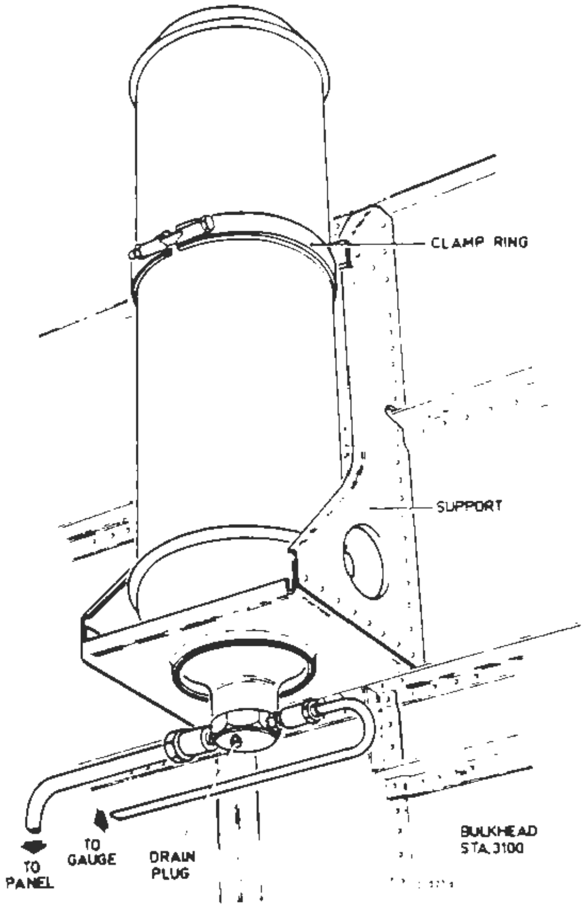
POROUS METAL FILTER

PNEUMATIC SYSTEM COMPONENTS

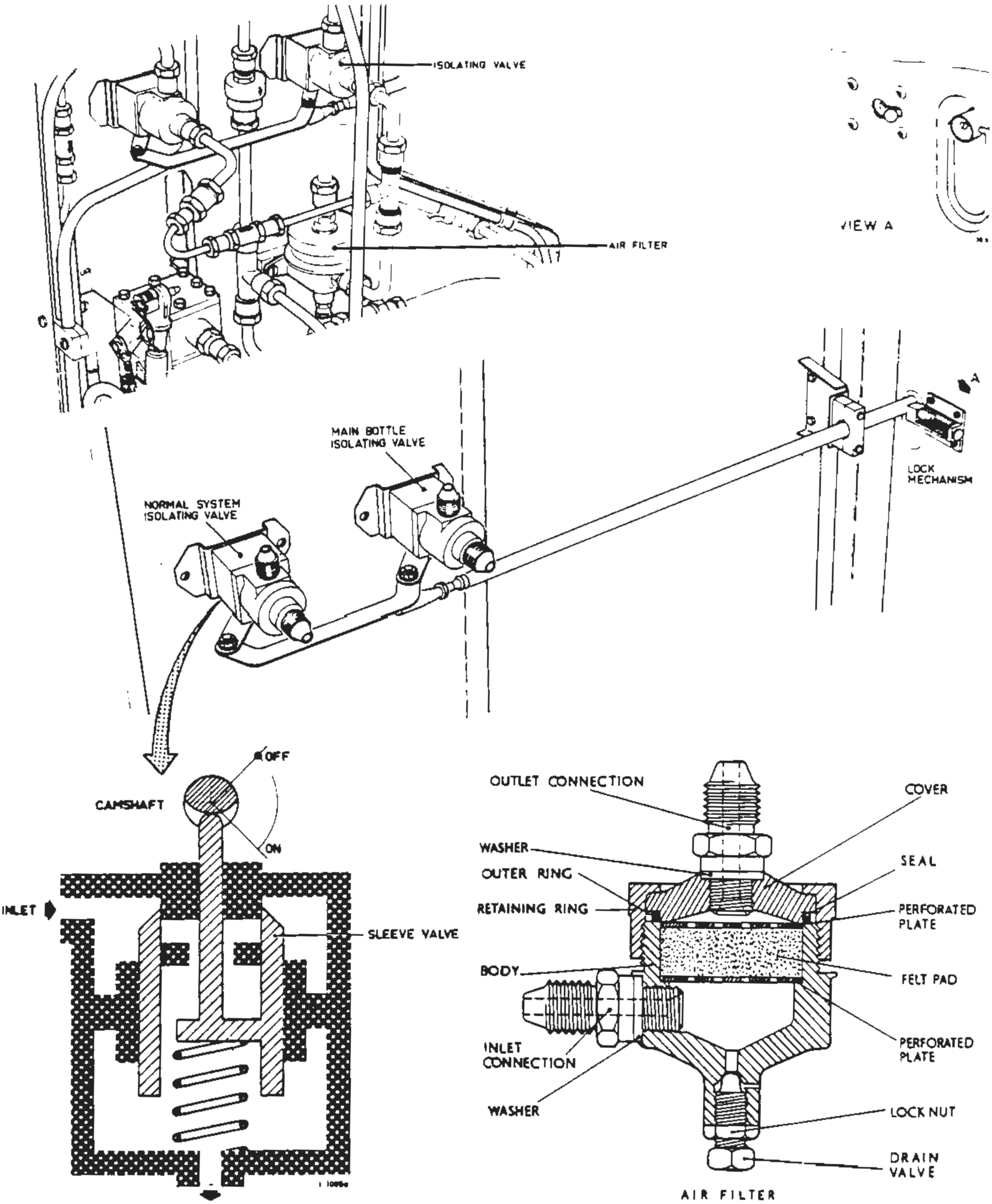


PNEUMATIC COMPARTMENT

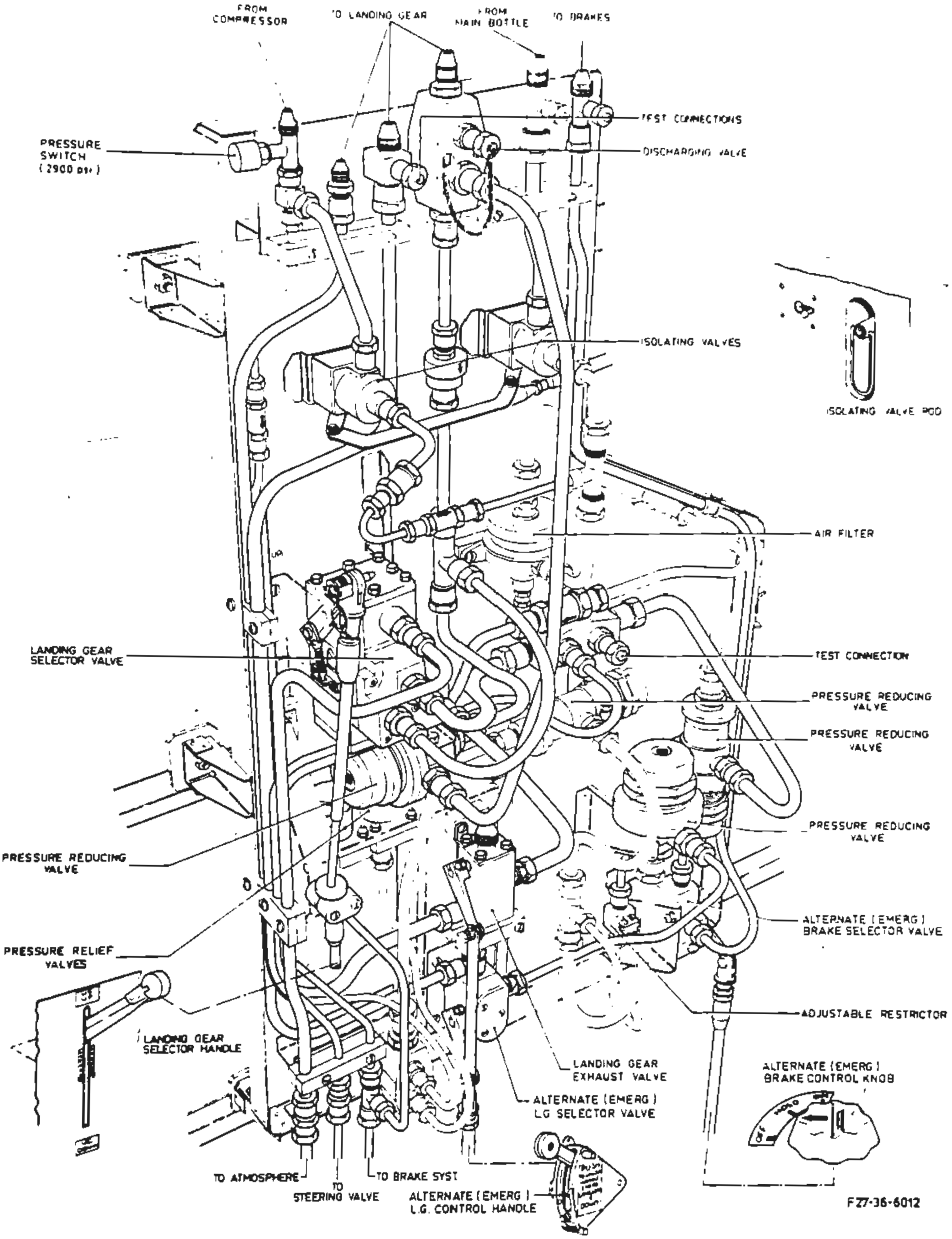




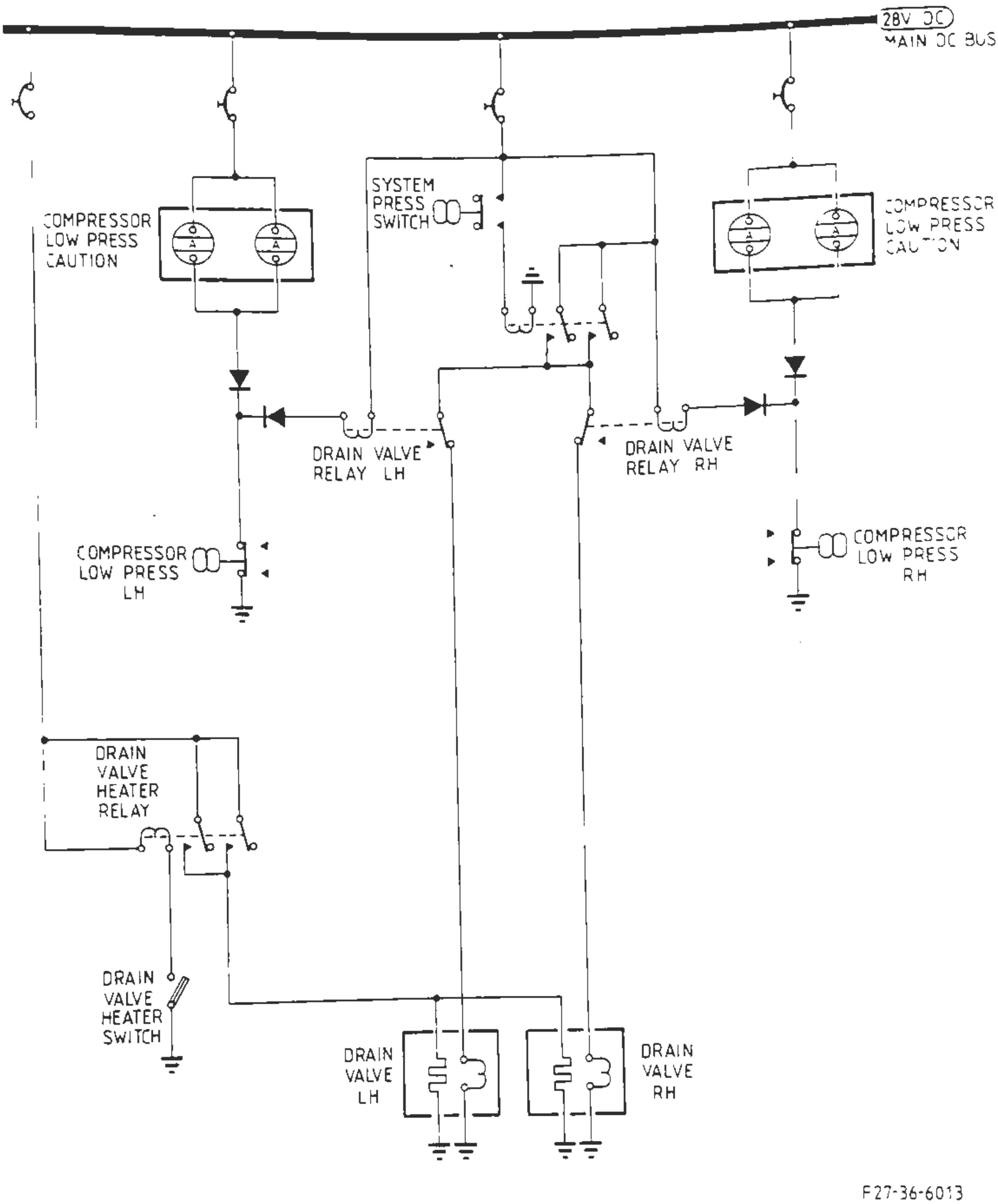
PNEUMATIC SYSTEM MAIN PRESSURE STORAGE BOTTLE



PNEUMATIC SYSTEM COMPONENTS



PNEUMATIC PANEL



DRAIN VALVE ELECTRICAL CIRCUIT

30.0 SERVICING AND MAINTENANCE INFORMATION

CAUTION: This information is to be considered for training only. In actual maintenance operations always refer to the Maintenance Manual.

NOTE: Water entering the system can cause serious malfunction. Therefore every step in maintenance must consider the prevention of water entering the systems.

A. Charging the storage bottles

As previously explained the minimum air pressure in the main and brake storage bottles should be 1500 psi and for the alternate storage bottles 1750 psi before take-off.
The bottles can be charged by the ground charge connection or by the aircraft compressors with running engines. The charging raste from the running engines is approx. 25 psi/minute at 10,000 rpm.
The charging rate of the alternate storage bottles can be increased by closing the isolating valves.

B. Discharging the system

A discharging valve situated in the pneumatic compartment enables the following to be deflated for maintenance purposes:

a. Supply systems
b. Landing gear down lines
c. Nose wheel steering System.

The isolating valves may be closed to hold the pressure in the main storage bottle during deflation of the system. The supply is then deflated by operating the discharge valve located under each dehydrator.

To release pressure in the normal brake system keep applying and release the brake pedals until the brake bottle pressure gauge indicates zero.

C. Permissible system leakage

The correct figures are given in the maintenance manual. It should be noted that temperature changes can effect the pressure by approx. 11 psi per degree centigrade.

D. Tracing leakage

In general it can be stated that large external leakages can be traced aurally or by application of a soapy water solution. Very small leaks can be traced by a special electronic leak detector.

To trace internal leakage it is necessary to have a clear understanding of the operation of the various components, since many components are venting air to ambient.

E. Primary functional check

This check can be carried out in flight up to 20,000 when a compressor failure is suspected.

A special primary functional check data table as is given in the maintenance manual shows the charging time of the main storage bottle related to flight altitude and engine rpm.

F. Secondary functional check

This check is carried out upon pilot's complaints or periodically on the ground with running engines. The charging figures are given in the maintenance manual in the secondary functional check data table.

G. Depressurizing

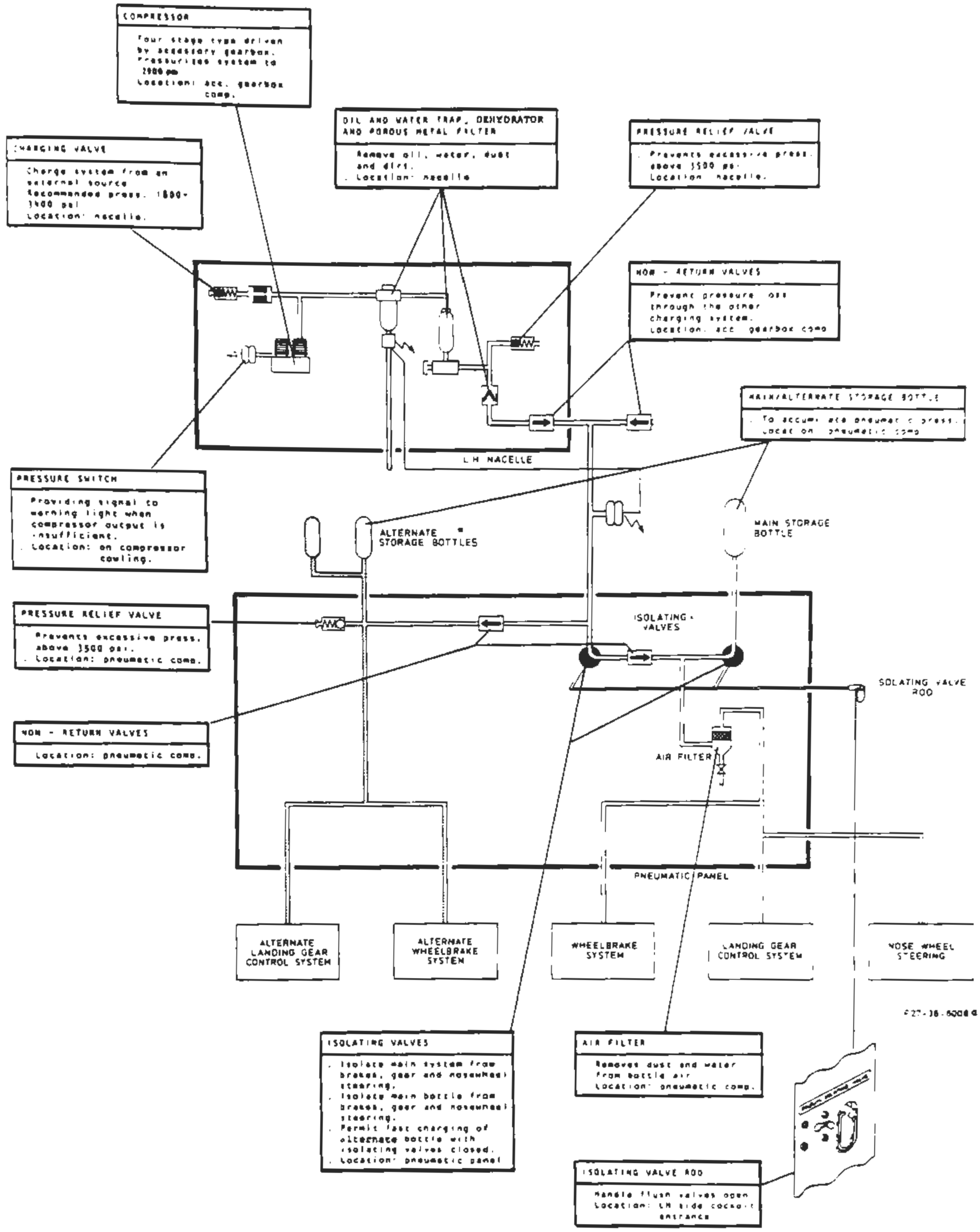
Before removing the dehydrator cartridge, the unit must be depressurized. This is done by fitting a deflation adaptor to the discharge valve at the bottom of the dehydrator.

The cartridge in the dehydrator contains activated alumina which must be checked frequently. The frequency is dependent on the general weather conditions. The alumina is to be renewed when the weight exceeds the figure given in the maintenance manual.

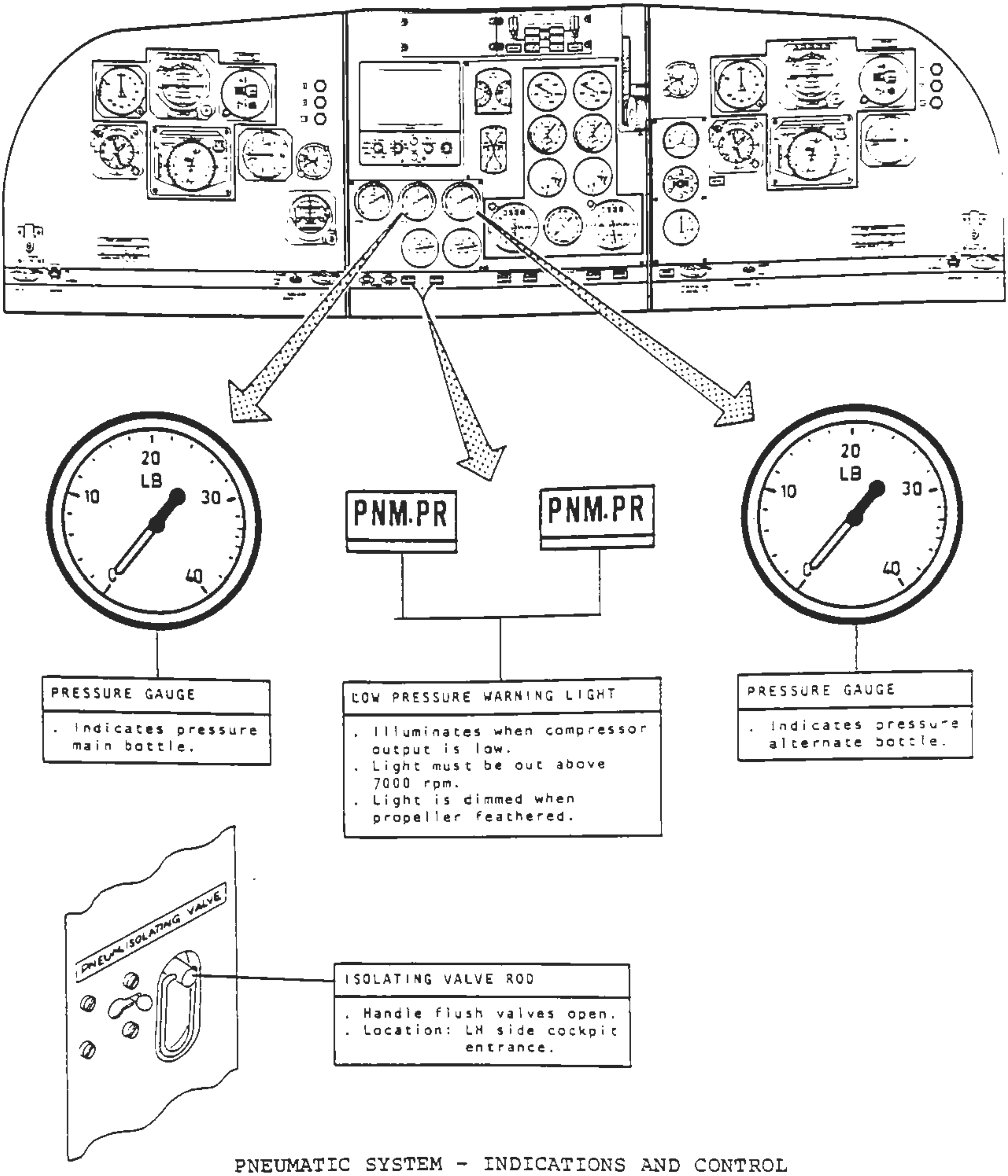
H. Air filter servicing

When any moisture is found during draining of the air filter housing, the felt pad must be replaced.

END



PNEUMATIC SYSTEM - COMPONENT SUMMARY



PNEUMATIC SYSTEM - INDICATIONS AND CONTROL

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36. PNEUMATIC SYSTEM

36. PNEUMATIC SYSTEM

00.0 GENERAL

The pneumatic system can be divided into a normal operating system used to:

a. Extend and retract the landing gear.
b. Operate the wheel brakes.
c. Operate the nose wheel steering.

and an alternate (emergency) operating system which is used to:

a. Extend the landing gear.
b. Operate the wheel brakes.

00.1 Pressure Supply System

Both operating systems are operating at a pressure of 2,800 psi supplied by two identical supply systems, one installed in each nacelle.
Each of the supply systems comprises:

a. A four stage air compressor installed on the engine-driven gear box. As one air compressor is sufficient for all pressure demands a single compressor or engine failure does not affect the operation of the pneumatic system. A failure of the air compressor is indicated by a light on the main instrument panel.

b. A ground charging valve installed in the nacelle which can be used to charge the pneumatic system or for maintenance purposes. A restrictor prevents excessive pressure surges during charging.

c. A pressure regulator, installed in the gearbox compartment, to regulate the supply pressure at 2,800 psi. When this pressure is reached the pressure regulator off-loads the air compressor by connecting the 3rd stage to ambient.

d. An oil and water trap installed in the nacelle, to extract oil and water delivered by the compressor. This unit must be drained frequently.

e. A dehydrator, also installed in the nacelle, acting as a chemical drier to remove residual moisture in the compressed air, because water even in very small quantities can cause serious malfunctioning of the pneumatic system especially at low temperatures.
The weight of the chemical unit must be checked frequently.

Downstream of the dehydrator are installed a cleanable porous metal filter, a pressure relief valve set at 3,500 psi and a non-return valve to prevent failure of one of the supply systems from affecting the other.

After passing through the non-return valve, the two supply systems are joined by a T-connection from where a single supply line is routed to a T-connection on the pneumatic panel in order to supply the operating systems. This panel is located on the left-hand side of the cockpit entrance.
The majority of the pneumatic components used in both operating systems is installed on the pneumatic panel. This panel including all components can be replaced as one unit.

00.2 Normal Operating System

The components on this panel used in the normal operating system are:

A. Two manually operated isolating valves, mechanically interconnected and operated by a rod installed through the sidewall of the pneumatic panel. One valve is installed in the pressure line just aft of the T-connection in order to isolate the normal operating system from the supply system. The other valve is installed to isolate the main storage bottle from the supply systems. The valves are used for instance, during an overnight stop for maintenance purposes, when a leakage occurs in flight or to charge the emergency storage bottle.

B. A main storage bottle is used to store sufficient compressed air to deal with the pressure demands during normal operation.
The air pressure stored in the main bottle is indicated in the cockpit on the main instrument panel.
To ensure normal system operation the minimum air pressure in this bottle before take-off should be 1,500 psi.
A drain plug is installed to drain the bottle periodically.

C. An air filter to clean the air from impurities. The filter consists of a felt pad and the filter housing itself can be drained periodically.

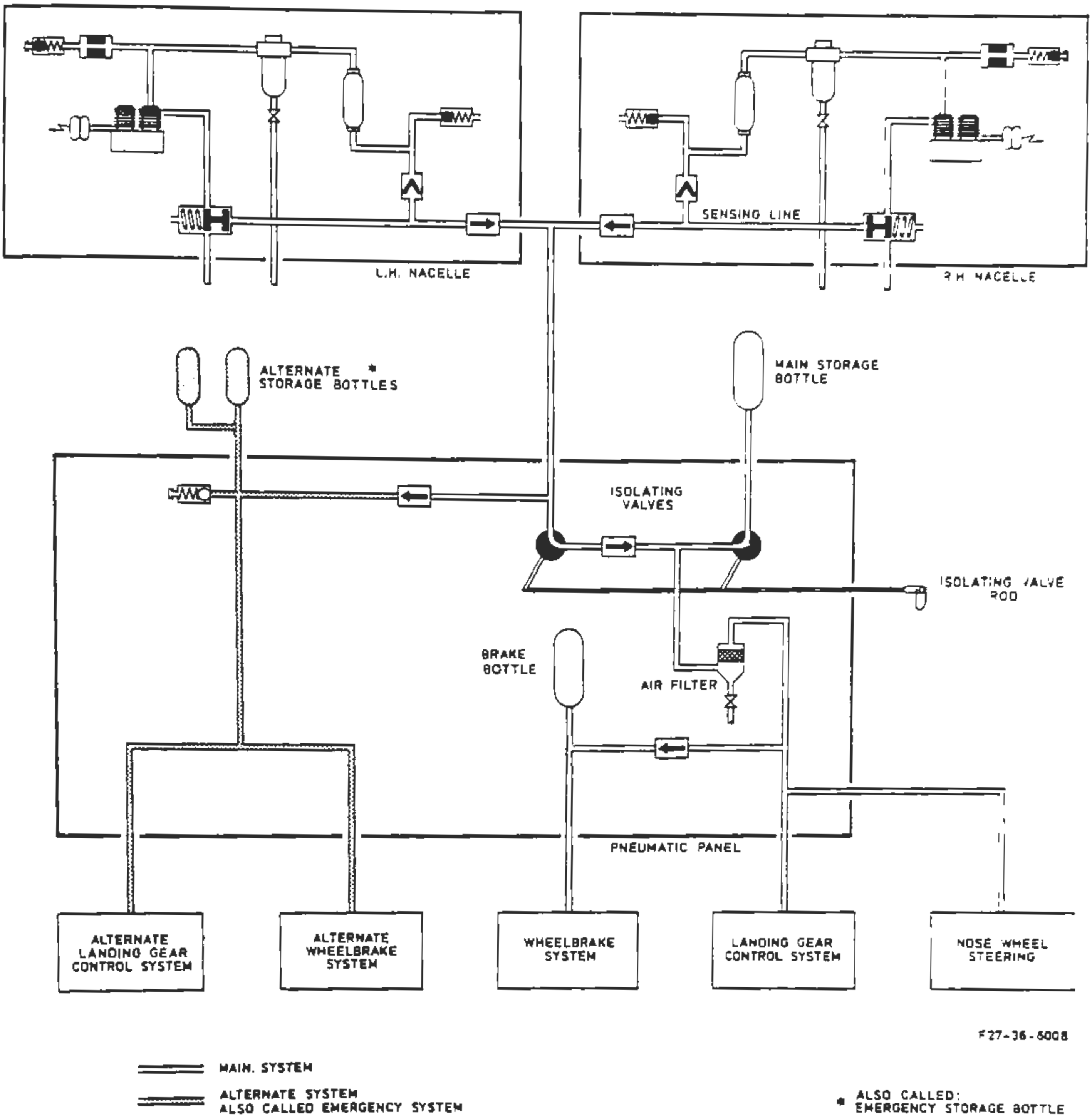
After passing the air filter piping routes the pressurised air via a pressure reducing valve -reducing the air pressure to 1,000 psi- to the nose wheel steering and the landing gear system.
The air pressure to lower the gear is further reduced to 100 psi by a pressure reducing valve in the down line.

Another piping is routed to the wheel brake system thereby passing a non-return valve, a pressure relief valve (3,500 psi) and a pressure reducing valve reducing the brake pressure to 1,000 psi.
A brake pressure storage bottle installed in the brake supply line ensures sufficient brake pressure for normal brake operation. The pressure in this bottle is displayed on the main instrument panel.
The minimum pressure in this bottle to ensure full brake operation is 1,500 psi before take-off.
A drain plug can be used to drain the bottle periodically.

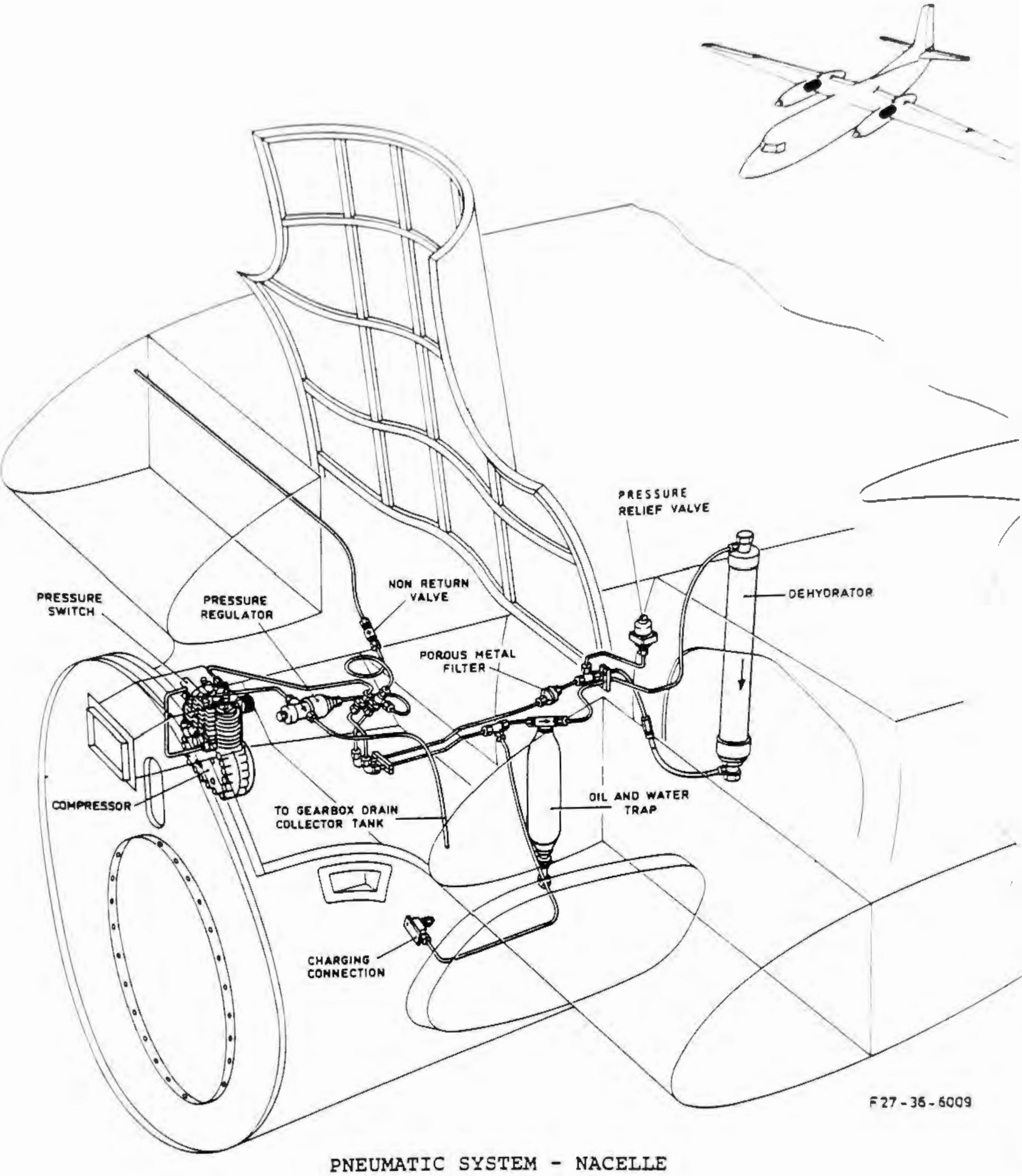
00.3 Alternate (Emergency) Operating System

The pressurised air routed to this system passes a non-return valve, a pressure relief valve (set at 3,500 psi) and a pressure reducing valve to reduce the air pressure to 1,000 psi before it is routed to the landing gear down lines (where another pressure reducing valve reduces this pressure to 100 psi) and the wheel brake system.
Alternate storage bottles installed in the alternate supply line ensures sufficient pressurized air to lower the landing gear and to stop the aircraft with the alternate brake system, provided the bottles are charged to 1,750 psi, which should be the minimum pressure in the bottle before take-off. The bottle pressure is indicated in the cockpit on the main instrument panel.
These bottles can also be drained periodically.

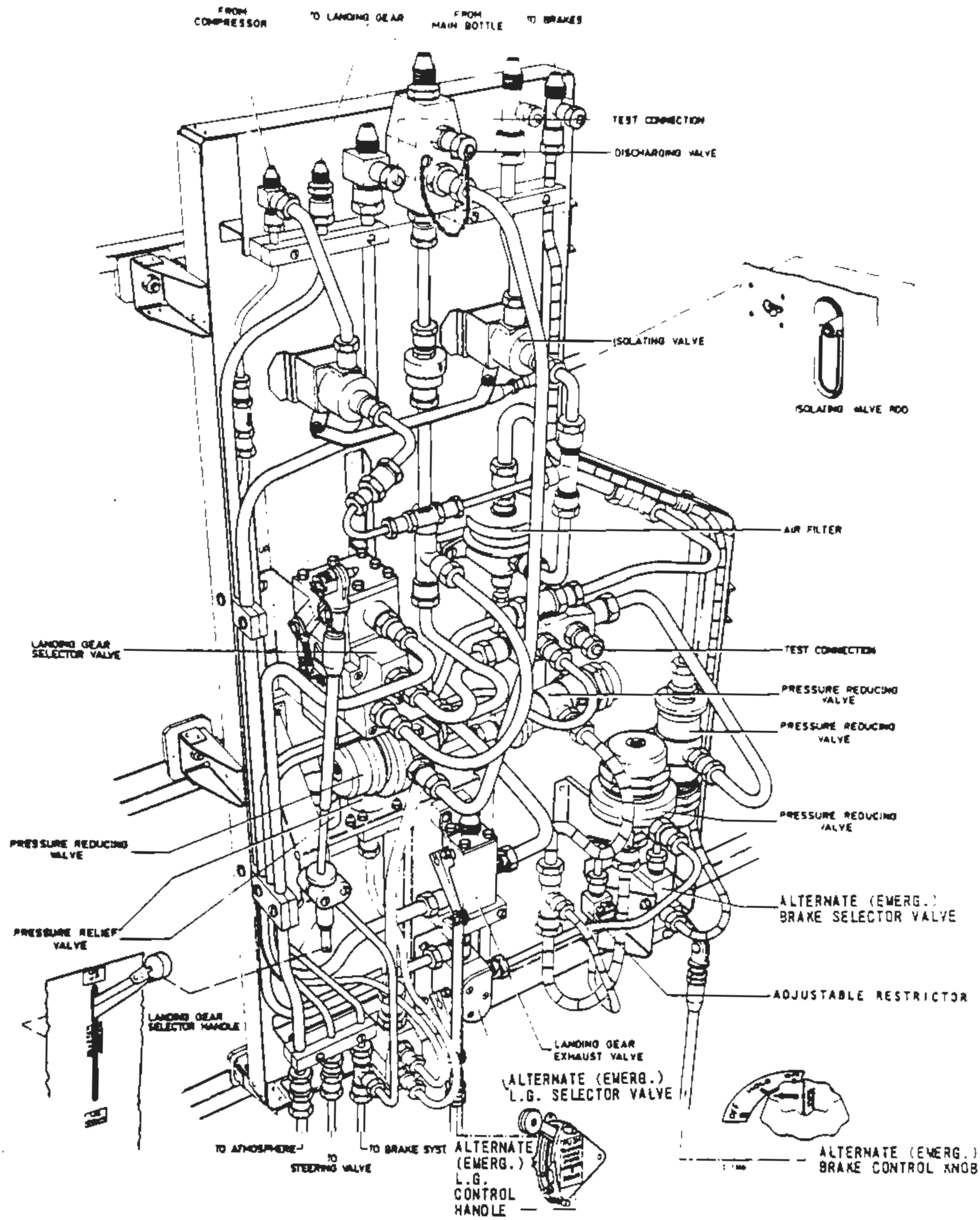
END



PNEUMATIC SYSTEM DIAGRAM



PNEUMATIC SYSTEM - NACELLE



PNEUMATIC PANEL

10.0 COMPONENTS

10.1 Pneumatic Compressor

The compressor consists of a light alloy crankcase in two halves bolted together. Integral with the front half section is a mounting flange which incorporates an oil feed hole for the compressor lubrication supply. The unit is mounted to the gearbox by adapters and a clampring.

Mounted above the crankcase are the cylinders which consist of a combined 1st and 2nd stage cylinder and a combined 3rd and 4th stage cylinder next to it. The cylinders are of steel and are provided with cooling fins. Operating inside the cylinders are pistons driven by cranks and connecting rods, which in turn are driven by the drive shaft through spur gears.

A. Cooling

Cooling air is drawn from an intake on the RH side of the upper engine cowling and is fed via a duct to the compressor which is provided with a sheet metal cowling to direct the air around the cylinder fins and also around the intercooler fins for the various stages of compression. The cooling air then escapes at the rear of the gearbox compartment over the wing leading edge. The 4th stage cylinder is oil-cooled.

B. Lubrication

Oil from the engine accessory gearbox is fed to the compressor via the oil inlet on the mounting flange and a gauze filter in the crankcase. The gauze filter is removable for cleaning purposes. The oil is then fed to a metering bush which supplies oil to the crankshaft bearings and via the external oil pipe to the 4th stage piston and cylinder. Splash-fed oil lubricates the 3rd stage from the 4th stage and then drains back to the crankcase. The 1st and 2nd stages are splash-lubricated. The oil then drains away into the crankcase and thence to the pump on the accessory gearbox.

C. Operation of the Compressor

1st Stage Induction

As the 1st and 2nd stage piston descends, air at atmospheric pressure is drawn past the 1st stage inlet valve via a filter.

1st Stage Compression and 2nd Stage Induction

On the upward compression stroke, the 1st stage inlet valve closes and the air is compressed and forced out of the cylinder through the 1st stage outlet valve and intercooler. As this action takes place, an annular space is formed below the rising piston, the compressed air enters this space via the 2nd stage inlet valve.

2nd Stage Compression and 3rd Stage Induction

As the piston moves downwards, the 2nd stage inlet valve closes and the air in the annular space is further compressed and forced out of the cylinder via the 2nd stage outlet valve. Here the pressure acts on the pressure switch and at the same time the cooler carries the air to the 3rd stage. As the air reaches the 3rd stage inlet valve the 3rd stage piston is moving upwards and the charge enters the annular space so formed between the two sets of piston rings.

3rd Stage Compression and 4th Stage Induction

The 3rd stage piston moves downwards closing the inlet valve and further compressing the air in the annular space. The air then passes out of the 3rd stage outlet, through the cooler assembly and inlet valve, and into the 4th stage cylinder, the piston of which is on the induction stroke.

4th Stage Compression and Delivery

As the 4th stage piston commences its compression stroke, the pressure closes the inlet valve, and the air is further compressed and forced out of the cylinder via the 4th stage outlet valve. This air then flows out of the compressor into the pneumatic system.

10.2 Compressor Failure Indication

A pneumatically operated pressure switch connected to the second stage outlet of each compressor illuminates an amber light on the main instrument panel placarded PNM. PR. in case the outlet pressure of the second stage drops below a predetermined level. The switch is fitted on the cowling of the compressor.
The light is automatically dimmed when the isolating relay is energized (see propeller system).

10.3 Oil and Water Trap (Nacelles)

When air under pressure from the system enters the inlet connection it passes through the inlet stack pipe and the restrictor and impinges on the baffle. Oil and water deposited on the baffle drains into the base of the trap, and the air flows through the outlet stack pipe to the aircraft pneumatic system. The provision of stack pipes prevents the deposit from entering the aircraft system. A drain provision at the bottom of the unit facilitates periodic draining.

10.4 Dehydrator (Nacelles)

The unit consists of a cylindrical body housing a removable canister charged with activated "Alumina". The open end of the body, which holds the outlet connector, is threaded to receive an end cap secured by a ring nut. A plate filter is situated in the end cap, secured by a circlip, to prevent the passage of small pieces of the charge into the system.

10.5 Porous Metal Filter (Nacelles)

This unit consists of a cone shaped porous metal filter enclosed within a filter body and an inlet connection, and clamped together by three bolts.

An arrow on an attached plate indicates the direction of flow.

10.6 Pressure Regulator (Gearbox Compartments)

The system air pressure enters through the high pressure connection, builds up in the pressure chamber and exerts a load on the piston. As the pressure increases, the valve pin in the piston is forced progressively harder against the ball and when the predetermined pressure of 2,800 psi is reached the ball is forced off its seat against the spring-load, thereby connecting the compressor 3rd stage with the exhaust. This direct connection to an open exhaust results in the compressor idling at low pressure.

This condition remains until the system pressure drops to about 2,400 psi allowing the springs to reseat the ball. The valve then closes and the cycle recommences. The exhaust is routed to atmosphere via a pipe down the gearbox compartment drain pipe.

10.7 Pressure Relief Valves (Nacelles)

As the air pressure builds up in the base, the valve seat and guide assembly are forced upwards against the main spring load. Simultaneously the small spring causes the valve to follow, thus keeping the valve closed. As the predetermined relieving pressure is reached, the valve is arrested in its movement by its flange coming into contact with the washer. Further increase in pressure and consequent continuation of the upward movement of the valve guide assembly withdraws the valve seat from the valve. Excess air pressure then dissipates through the drilling in the valve guide and the exhaust to atmosphere.

As the pressure drops, the main spring overcomes the smaller air pressure exerted on the valve seat and the valve closes to prevent further escape of air.

10.8 Charging Connection (Nacelles)

To protect the system from too high a temperature or pressure rise, due to excessive charging rates, a restrictor is mounted between the charging valve and the line in the connection mounting body.

10.9 Isolating Valve (Pneumatic Compartment)

With the valve operating lever in the OFF position the bottom valve sleeve, under the influence of the spring loading is held against the seat at the root end of the top valve sleeve extension, and inlet pressure cannot be transmitted through the valve. Upon actuation of the lever from the OFF to the ON position, the camshaft is rotated, the spring-loaded locking roller rides out of its groove in the camshaft, the central cam portion forces the cam follower down, which in turn moves the valve stem downwards. The valve stem moves the bottom valve sleeve away from its seat. Air then passes through the drillings in the top valve sleeve to the outlet connection. On the final movement of the hand lever the roller drops into the second axial groove in the camshaft to spring-lock it in that position.

Valves OFF means that the operating rod protrudes from the side panel. When the operating rod is flush the valves are ON. The operating rod is locked in both positions.

10.10 Pressure Storage Bottles (Pneumatic Compartment)

The main storage bottle is mounted in the pneumatic compartment. The bottle is of steel construction and has a capacity of 750 cu. in. The lower fitting is provided with two connections and a drain plug. Stack pipes prevent moisture, accumulated in the lower part of the bottle, from entering the system. Any residue may be drained by unscrewing the drain plug in the fitting. (The alternate (emergency) and brake storage bottles are identical but smaller in capacity).

10.11 Air Filter (Pneumatic Compartment)

The filter is located on the pneumatic panel and is provided to filter out possible scale and dust from the air supplied from the bottle.

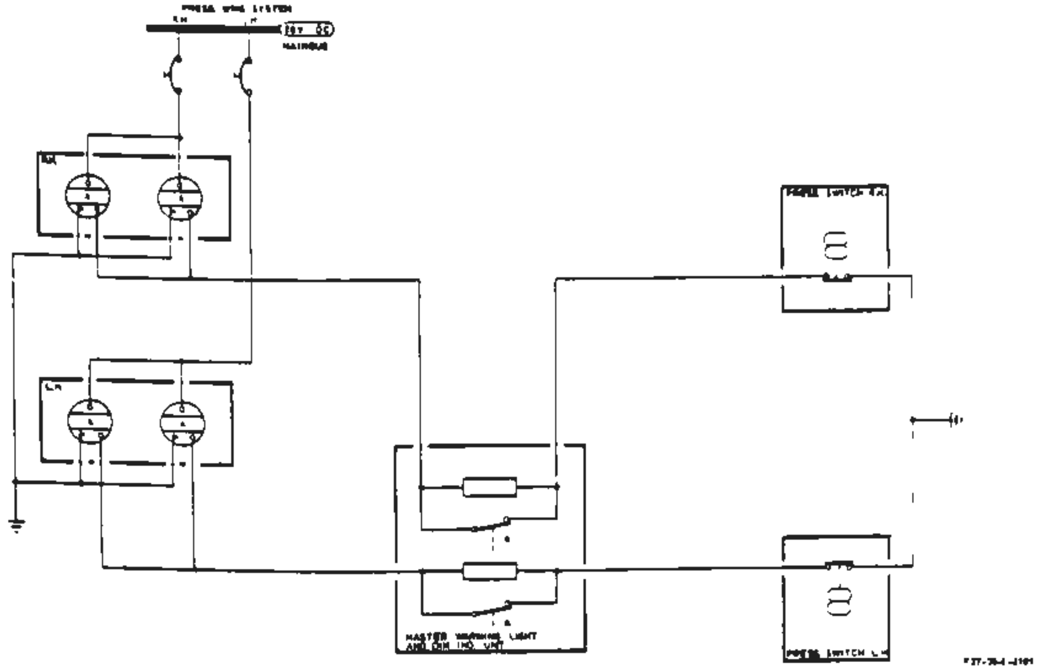
The filter has a hollow cylindrical body with an inlet connection screwed into its side and a drain-plug with lock nut screwed into the bottom.

A filter element, consisting of a felt pad sandwiched between two perforated plates, is housed in the body.

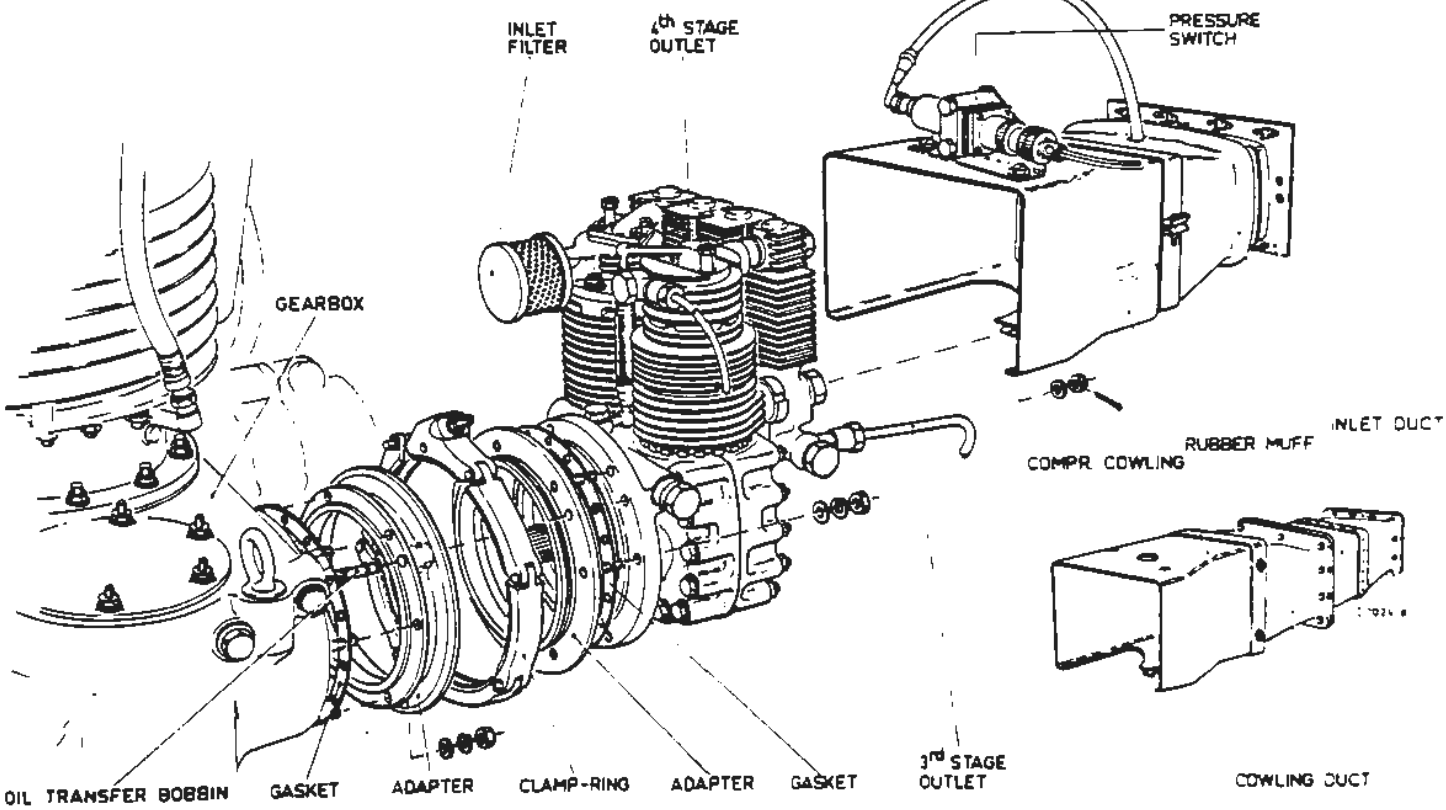
10.12 Piping

Rigid pipes with A.G.S. type connectors are used throughout the system. Swivel couplings are used on the landing gear to ensure a positive supply between the rigid pipes and the moving parts of the landing gear. "Aeroquip" flexible hoses for the gauge lines are used between the cockpit floor and the instrument panel.

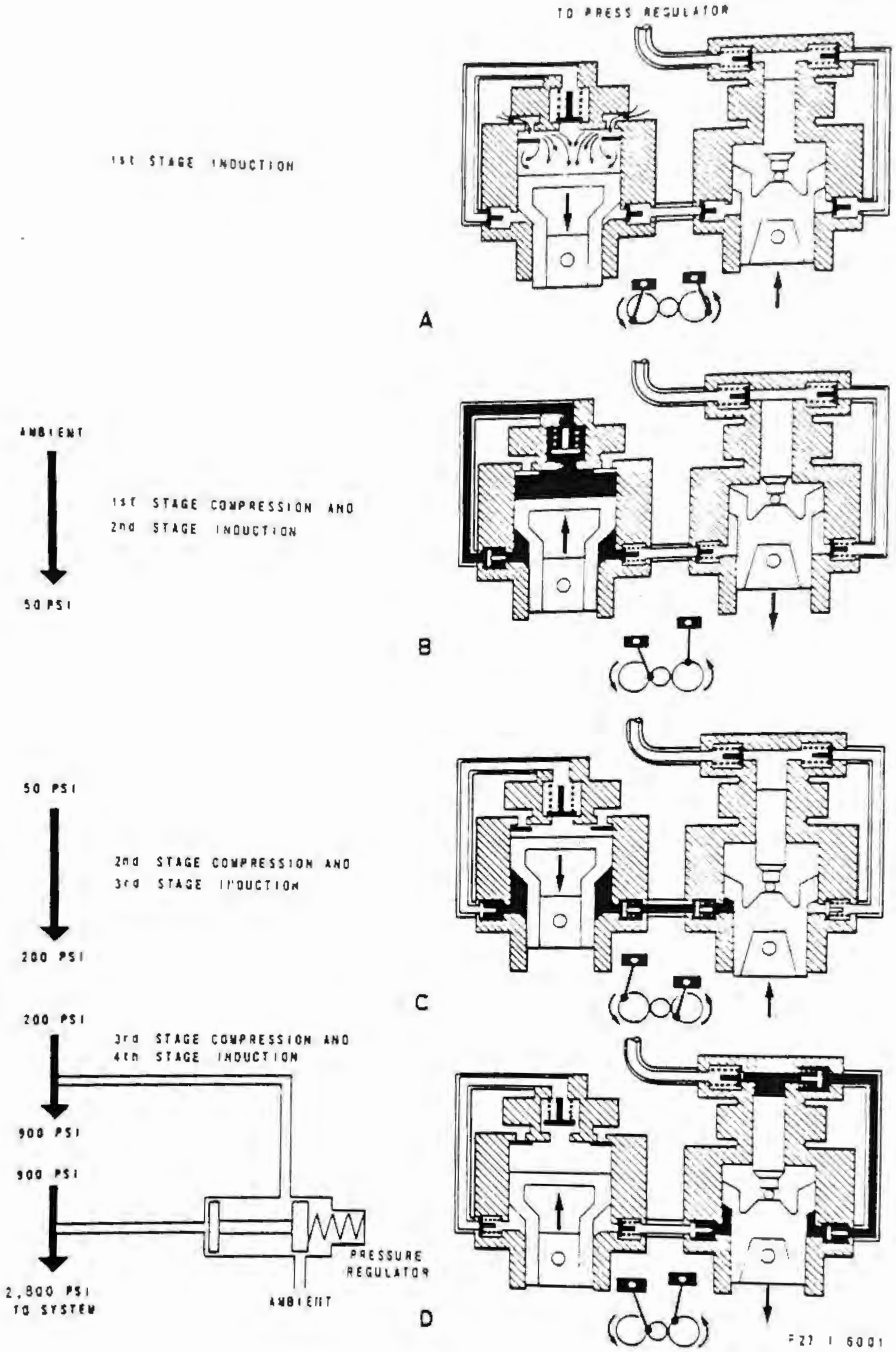
END



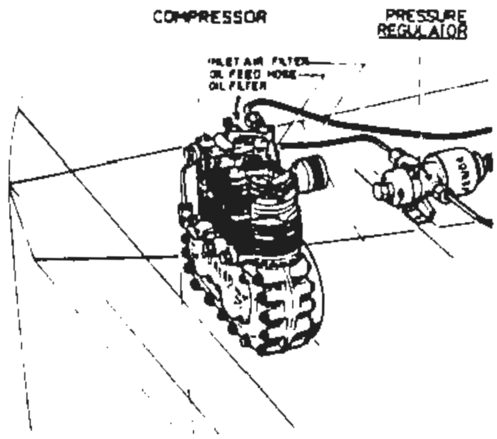
COMPRESSOR FAILURE INDICATION SYSTEM

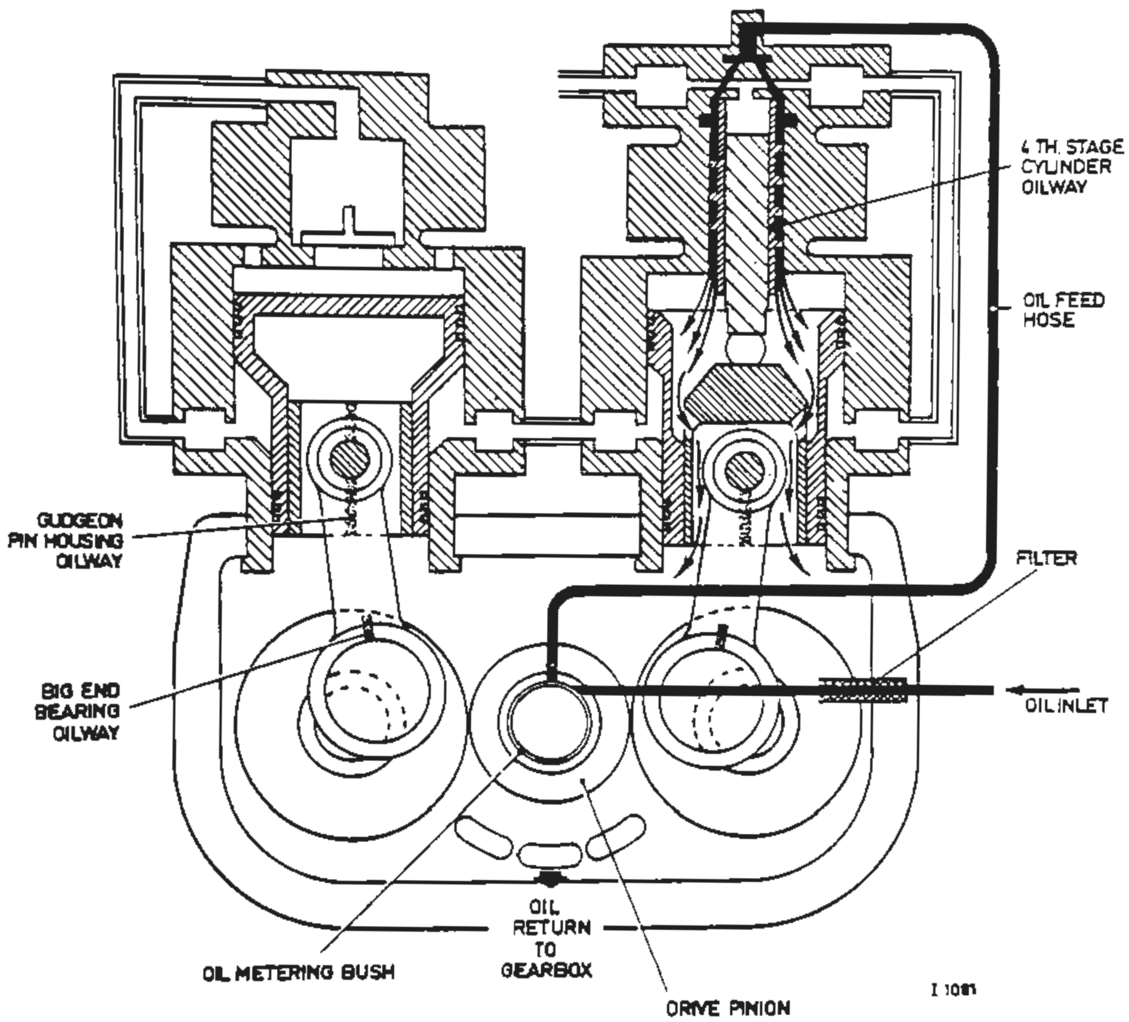


EXPLODED VIEW OF PNEUMATIC COMPRESSOR INSTALLATION

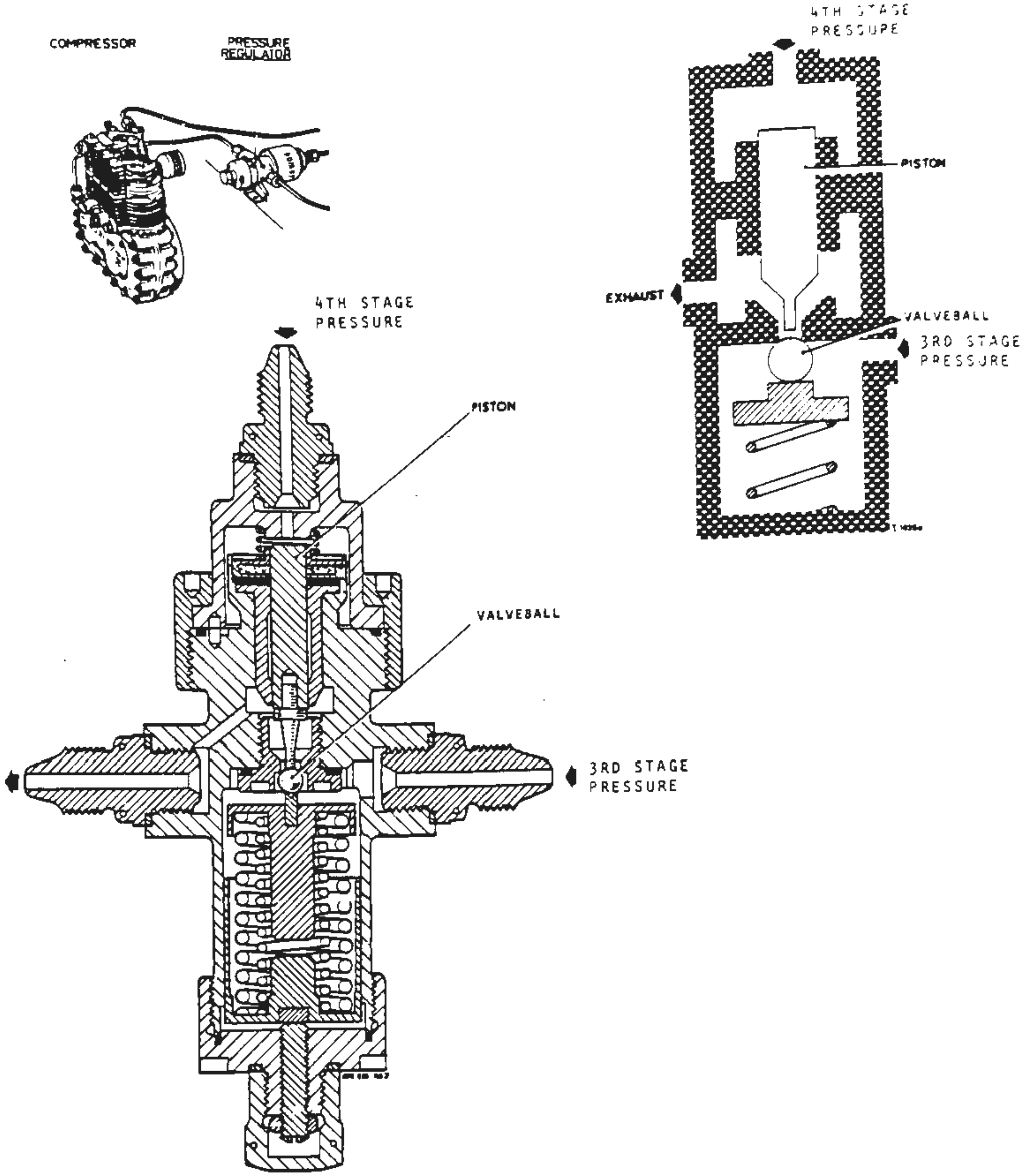


PNEUMATIC COMPRESSOR - FUNCTIONAL DIAGRAM

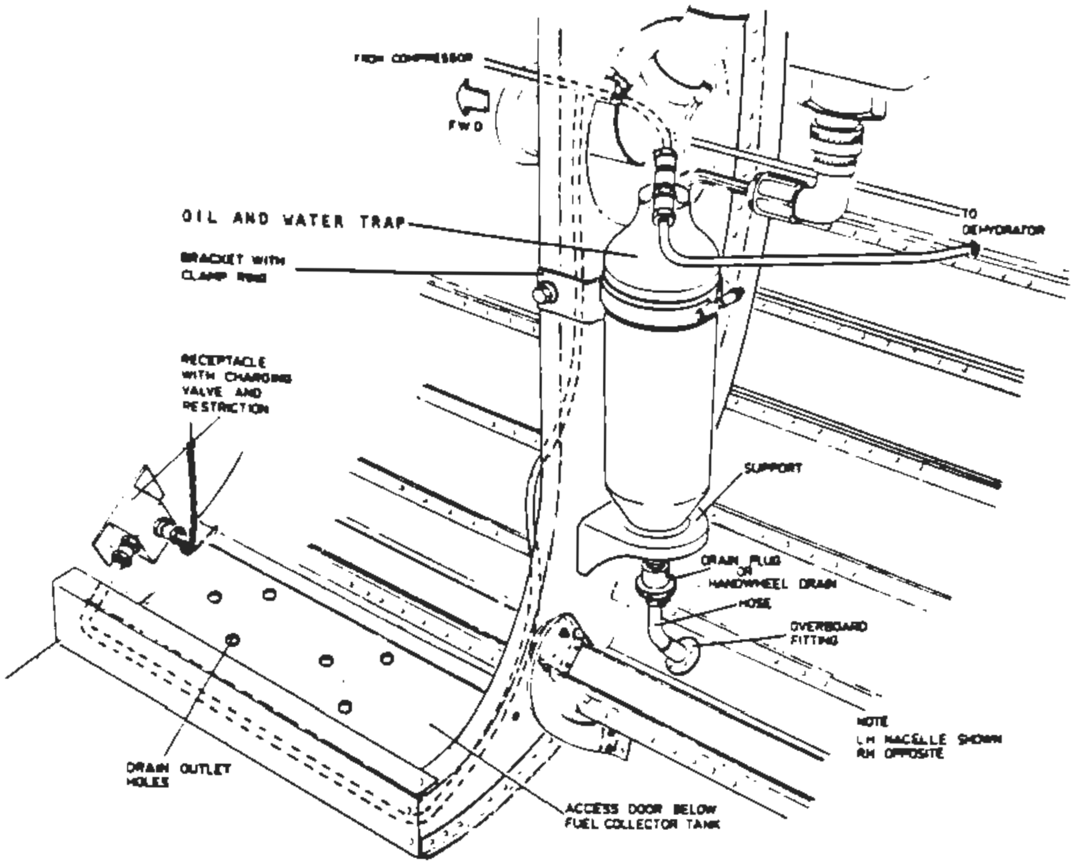


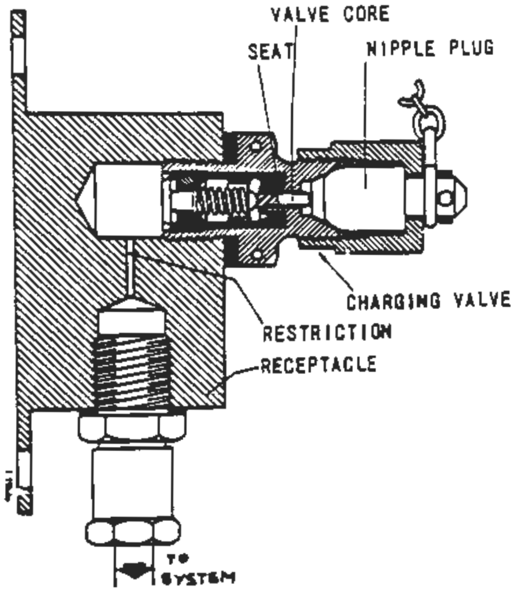


PNEUMATIC COMPRESSOR - LUBRICATION SYSTEM

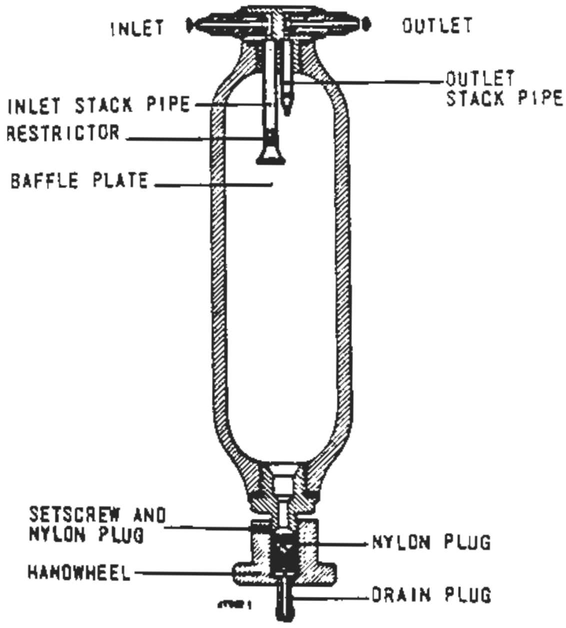


PNEUMATIC SYSTEM PRESSURE REGULATOR



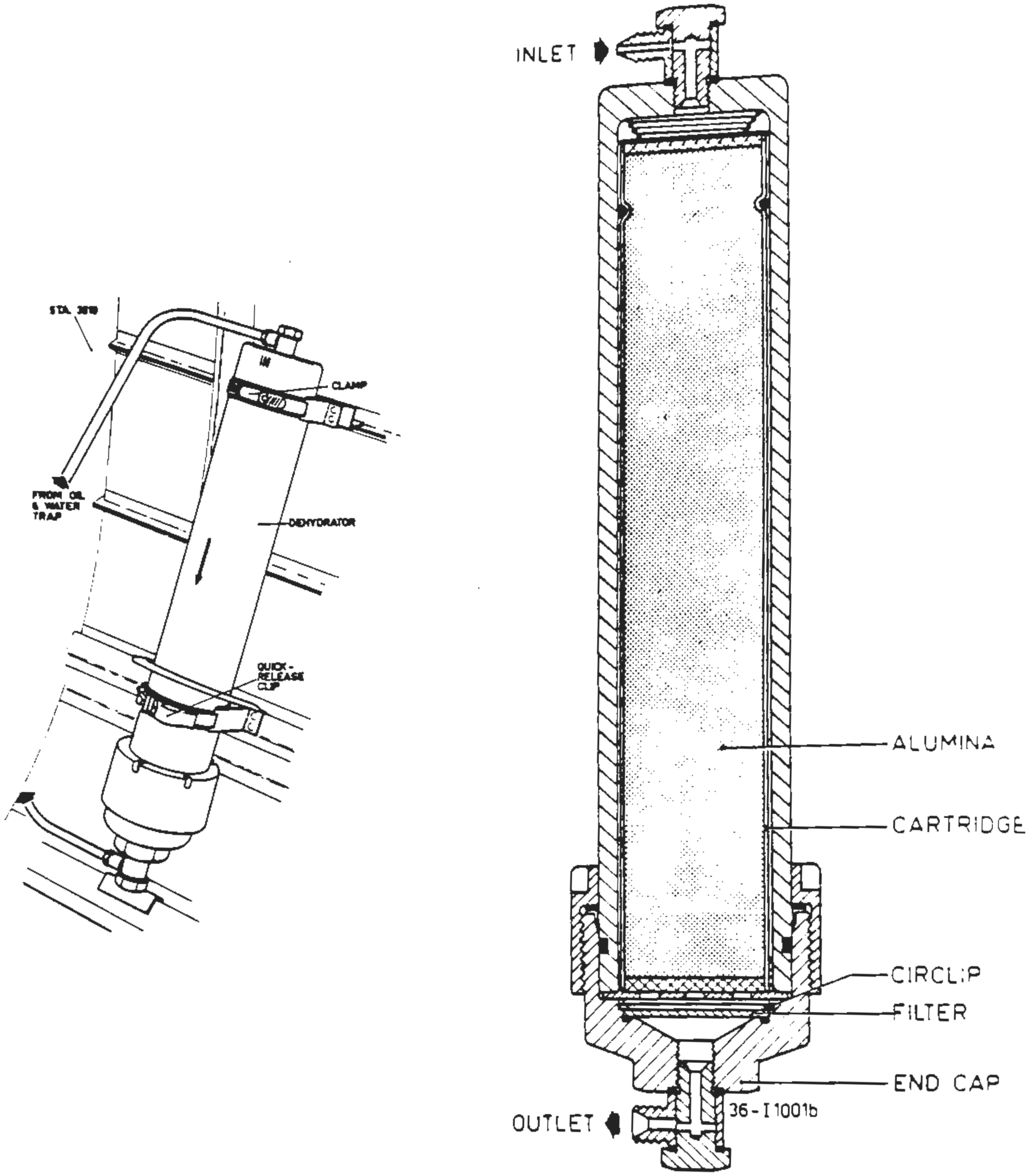


GROUND CHARGING VALVE

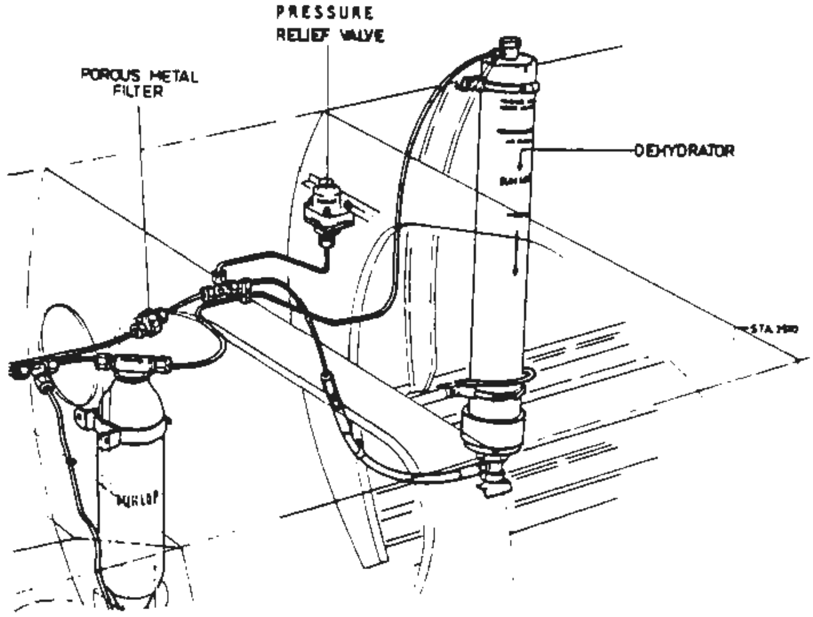


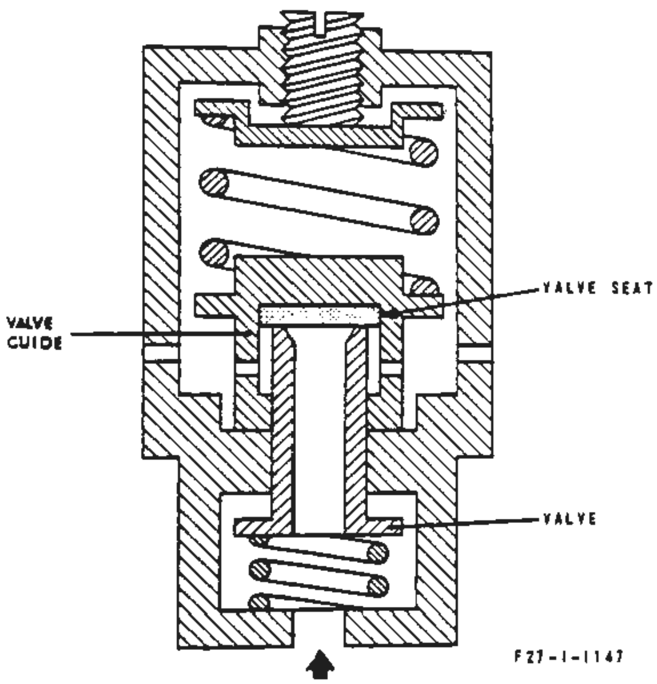
OIL AND WATER TRAP

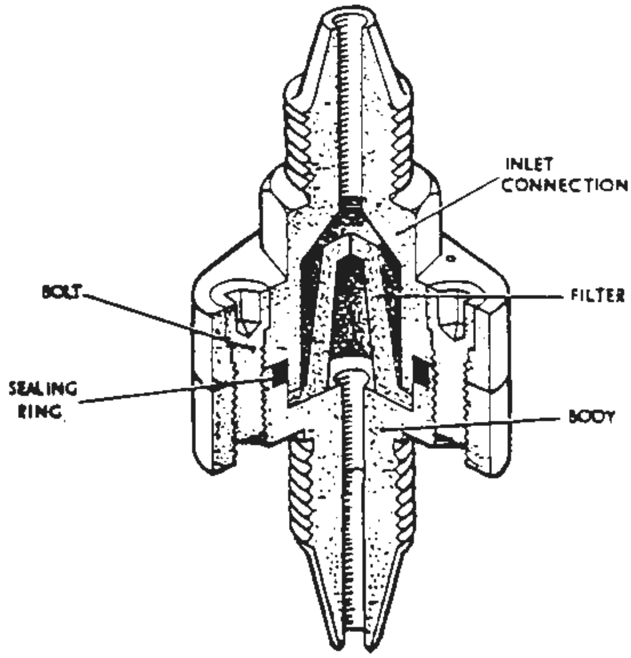
PNEUMATIC SYSTEM COMPONENTS


FROM OIL & WATER TRAP
CLAMP
DEHYDRATOR
QUICK-RELEASE CLIP
INLET
ALUMINA
CARTRIDGE
CIRCLIP
FILTER
END CAP
OUTLET
36-I1001b

DEHYDRATOR



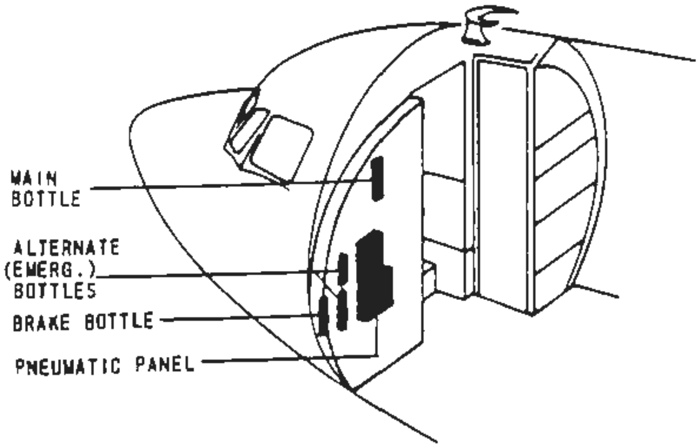




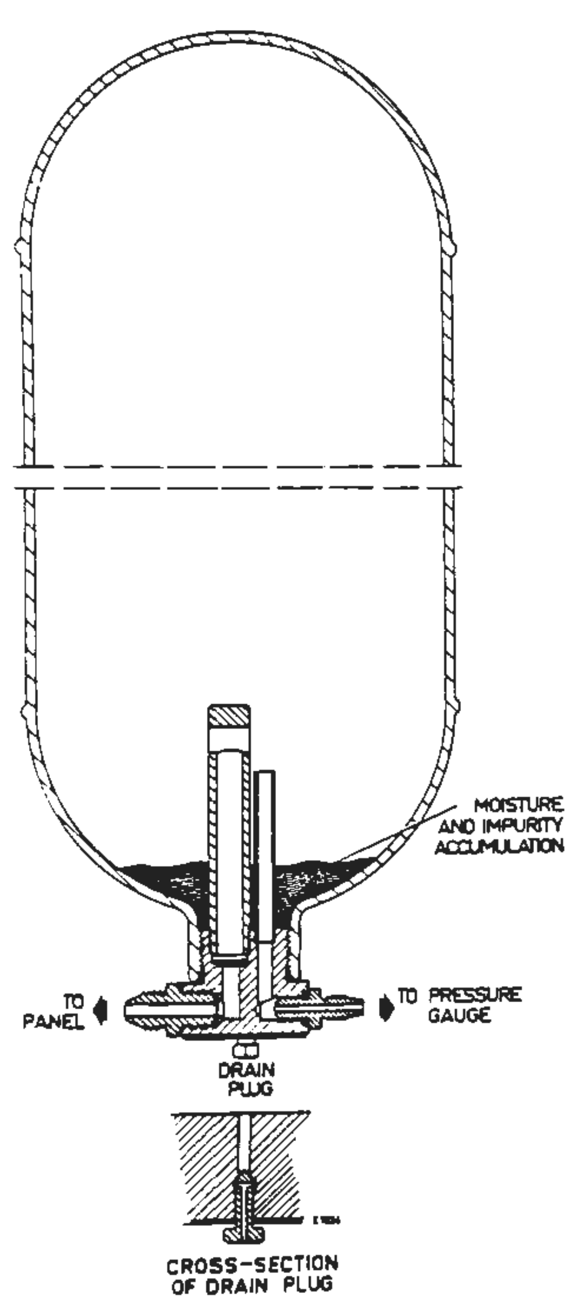
PRESSURE RELIEF VALVE

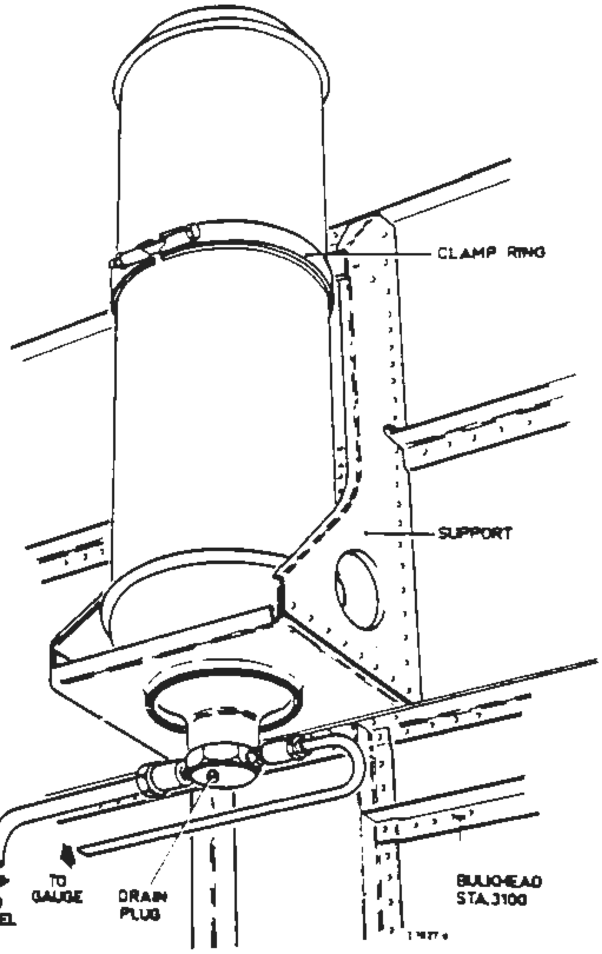
POROUS METAL FILTER

PNEUMATIC SYSTEM COMPONENTS

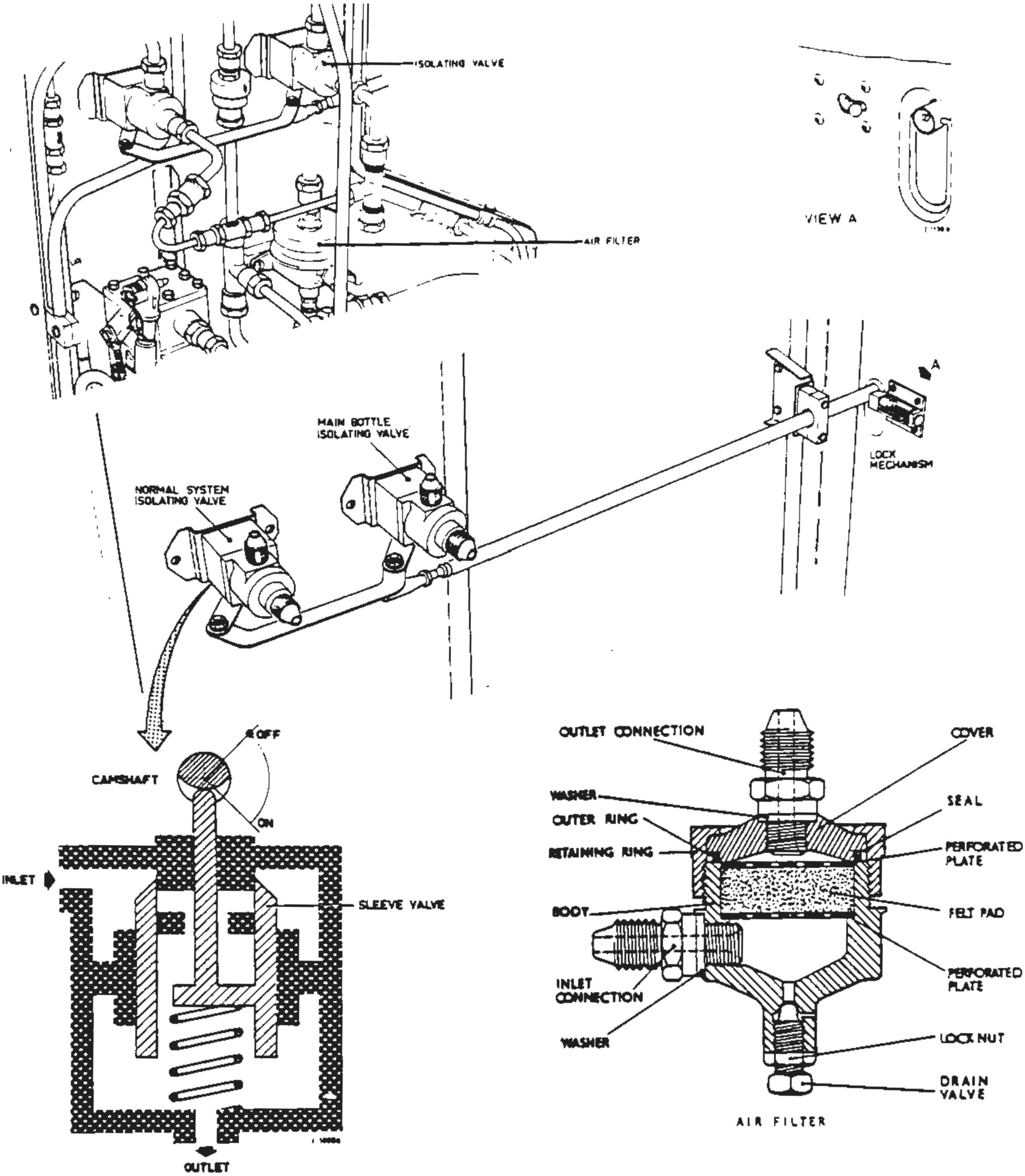


PNEUMATIC COMPARTMENT





PNEUMATIC SYSTEM MAIN PRESSURE STORAGE BOTTLE



PNEUMATIC SYSTEM COMPONENTS

30.0 SERVICING AND MAINTENANCE INFORMATION

CAUTION: This information is to be considered for training only. In actual maintenance operations always refer to the Maintenance Manual.

NOTE: Water entering the system can cause serious malfunction. Therefore every step in maintenance must consider the prevention of water entering the systems.

A. Charging the Storage Bottles

As previously explained the minimum air pressure in the main and brake storage bottles should be 1500 psi and for the alternate storage bottle 2,500 psi before take-off.
The bottles can be charged by the ground charge connections or by the aircraft compressors with running engines. The charging rate from the running engines is approx. 25 psi/minute at 10,000 rpm.
The charging rate of the alternate storage bottle can be increased by closing the isolating valves.

B. Discharging the System

A discharging valve situated in the pneumatic compartment enables the following to be deflated for maintenance purposes:

a. Supply Systems.
b. Landing Gear Down Lines.
c. Nose Wheel Steering System.

The isolating valves may be closed to hold the pressure in the main storage bottle during deflation of the system. The supply system is then, however, deflated by unscrewing the drain plug of the oil and water trap by not more than ½ turn.

To release pressure in the normal brake system keep applying and releasing the brake pedals until the brake pressure gauge indicates zero.

To release pressure in the alternate system, operate the alternate brake control knob until the alternate system gauge indicates zero.

C. Permissible System Leakage

The correct figures are given in the maintenance manual. It should be noted that temperature changes can effect the pressure by approx. 11 psi per degree centigrade.

D. Tracing Leakage

In general it can be stated that large external leakages can be traced aurally or by application of a soapy water solution. Very small leaks can be traced by a special electronic leak detector.

To trace internal leakage it is necessary to have a clear understanding of the operation of the various components, since many components are venting air to ambient.

E. Primary Functional Check

This check can be carried out in flight up to 20,000 feet when a compressor failure is suspected.

A special primary functional check data table as is given in the maintenance manual shows the charging time of the main storage bottle related to flight altitude and engine rpm.

F. Secondary Functional Check

This check is carried out upon pilot's complaints or periodically on the ground with running engines. The charging figures are given in the maintenance manual in the secondary functional check data table.

G. Draining

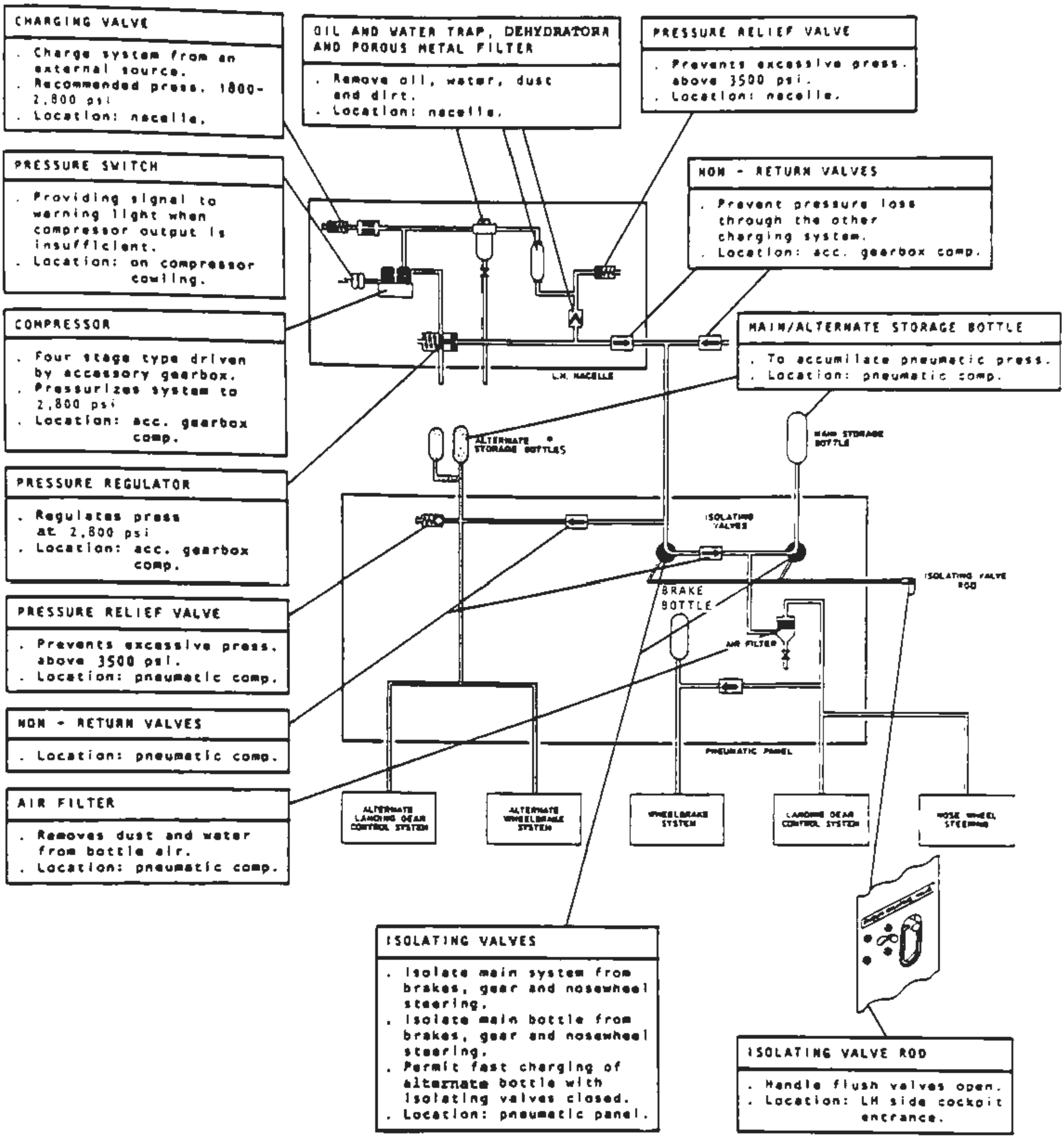
The oil and water trap can be drained by turning a handwheel ½ turn. It is recommended to drain this trap after the last flight of the day or after each flight in cold weather conditions.

The cartridge in the dehydrator contains activated alumina which must be checked frequently. The frequency is dependent on the general weather conditions. The alumina is to be renewed when the weight exceeds the figure given in the maintenance manual.

H. Air Filter Servicing

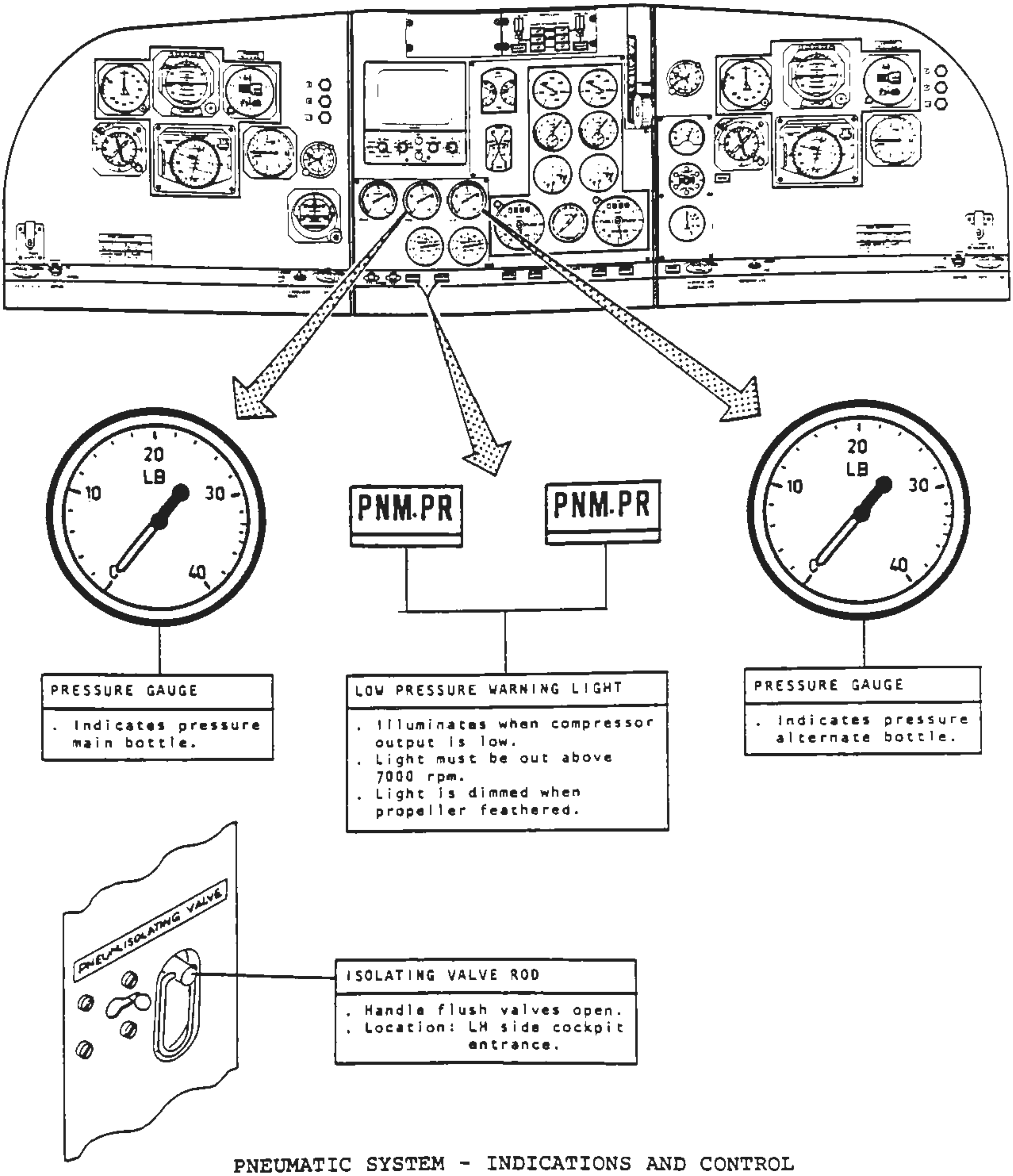
When any moisture is found during draining of the air filter housing the felt pad must be replaced.

END

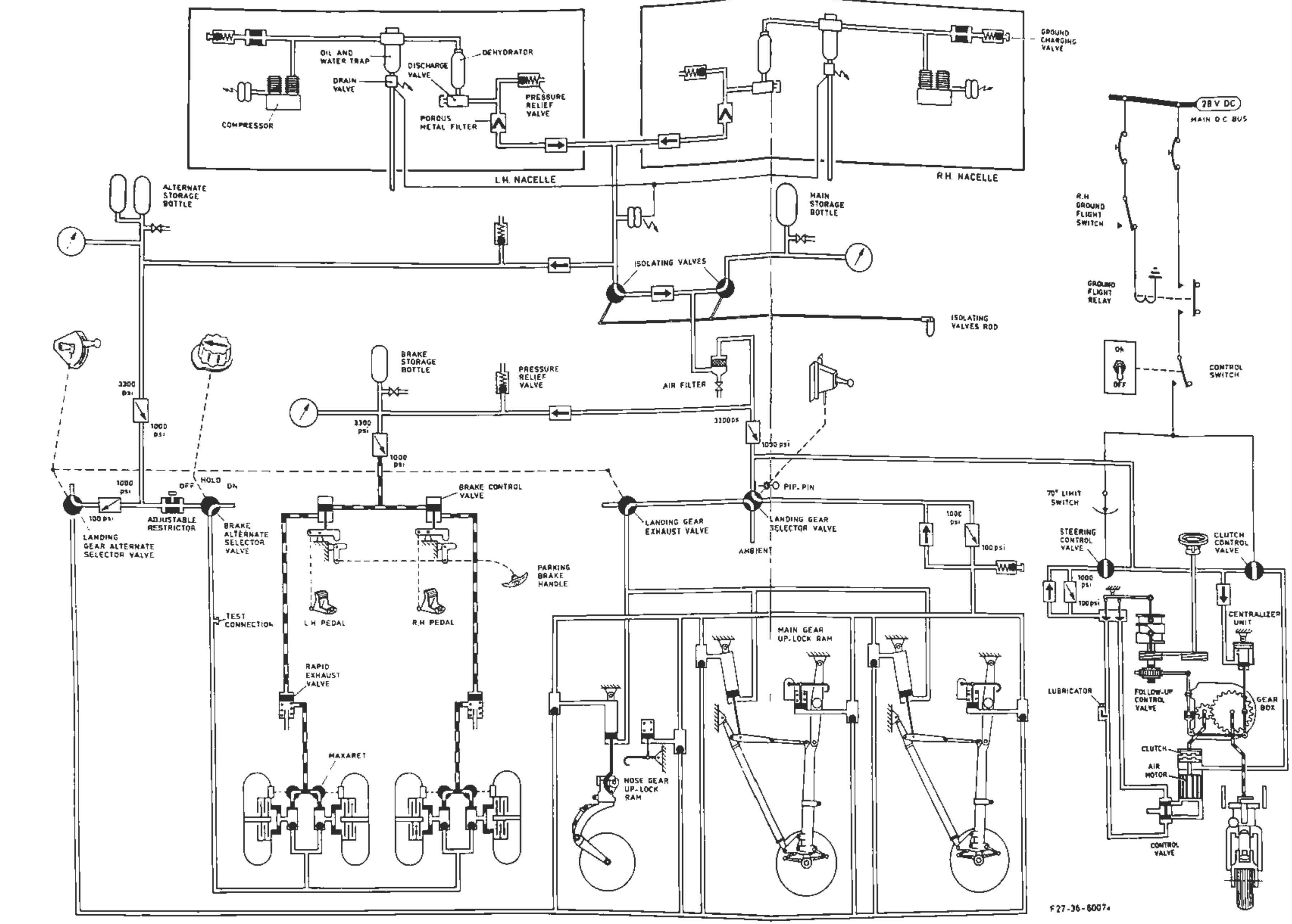


F27-36-6015

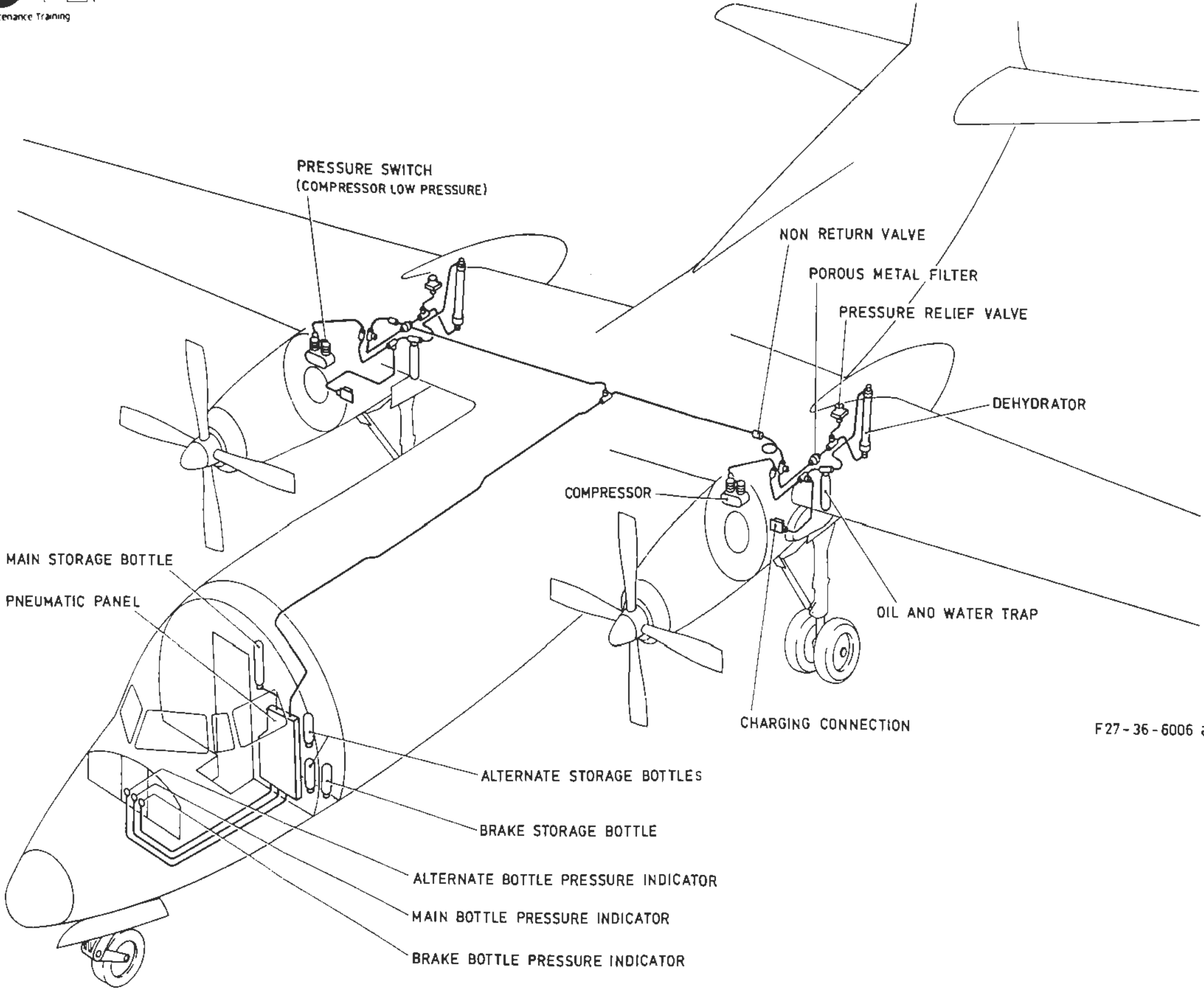
PNEUMATIC SYSTEM - COMPONENT SUMMARY



PNEUMATIC SYSTEM - INDICATIONS AND CONTROL



PNEUMATIC SYSTEM INTEGRATION



PNEUMATIC SYSTEM INSTALLATION

38. WATER/WASTE

00.0 GENERAL

A gravity-feed water system supplies wash water for use in the wash basin in the toilet compartment only. The water is stored in a tank located behind the toilet compartment.
Wash water is fed from the tank to a faucet above the wash basin. Used water in the basin can be drained overboard through a drain valve, opened by a knob and kept closed by a spring to prevent loss of cabin air.
To prevent freezing of the overboard drain line, a constant flow of cabin air is allowed to pass through an orifice into the drain line.
The water tank can be pressure filled through a tank filler connection on an external ground service panel, located on the RH side of the rear fuselage. A tank overflow line connected to the same service panel prevents overfilling of the tank.

A waste disposal system is also located in the toilet compartment. It provides a means of maintaining the toilet assembly in a clean and sanitary condition.
The system consists of a waste tank, a flushing motor-pump-assembly to wash down wastes, and a drain valve assembly for servicing. The system is provided with a timer to operate and limit the operation of the motor-pump-filter assembly. The toilet flush cycle is actuated by pushing the flush button on the toilet assembly. When operated the pump draws liquid from the waste tank through a rotating filter into the bowl.
A ground service panel is located on the RH rear side of the fuselage.

END

10.0 WASH-WATER SYSTEM

10.1 Water Tank

A fibreglass-reinforced plastic tank with a 15-litre capacity is installed behind the toilet compartment.

NOTE: In the F27 troopship the water tank is located in the toilet compartment self.

The tank has on the top side connections for filler-, overflow-, and ventlines, and at the bottom a T-connection for the faucet supply line and the tank drain valve.

10.2 Tank Drain Valve

A manually operated valve is installed between the T-connection on the water tank and the filler line.
The valve permits the tank to be drained via the filler line connection on the service panel.
The valve is a standard plug-type shut-off valve with a control handle.

10.3 Wash-Water Ground Service Panel

The ground service panel is located on the RH side of the rear fuselage.
It is accessible through a hinged panel secured by two quick-release fasteners.
The service panel contains connections for the filler- and overflow lines and a guard plate, which prevents replenishing with the overflow connection capped.
The connections are capped to prevent overboard spillage of water. The caps are secured to the structure by means of chains.
The maximum fill pressure is 5 psi.

END

20.0 WASTE DISPOSAL SYSTEM

20.1 Waste Tank

A fibreglass-reinforced plastic tank is mounted to the aircraft by means of bolts. The bottom of the tank is contoured such that the lowest point is at the drain valve outlet. On top of the tank are mounted a bowl-, a drain valve- and a motor-pump-filter assembly. A spray pipe is mounted in the upper part of the tank to flush it during servicing.

20.2 Bowl Assembly

The assembly is made of stainless steel and is highly polished to ensure proper cleaning during toilet flushing. A spray pipe is mounted under the bowl to deliver filtered flush water in a powerful swirl pattern.

20.3 Waste-Tank Drain Valve

A drain valve is located in the waste tank, the valve is springloaded to shut, sealing of the tank drain opening on the bottom. The valve is actuated by a control cable extending to the service panel.
Pulling the control handle on the service panel causes the valve to open, allowing accumulated waste to drain from the tank through the drain opening.
Releasing the handle permits the drain valve to reseat with a snap action providing a tight and positive seal of the tank outlet.
The spherical rubber valve seats into a matching spherical metal valve seat on the bottom of the tank.

20.4 Waste Tank Ground-Service Panel

The ground service panel is located on the RH side of the rear fuselage below the floor line and is accessible through a hinged panel secured by two quick-release fasteners.
The service panel contains a 3.5-inch wide connection to drain the waste tank, a control handle and a connection to refill the waste tank with water and chemicals. The connections are capped. The caps are secured to the structure by means of chains.
The control handle can be turned to lock the drain valve in the open position.

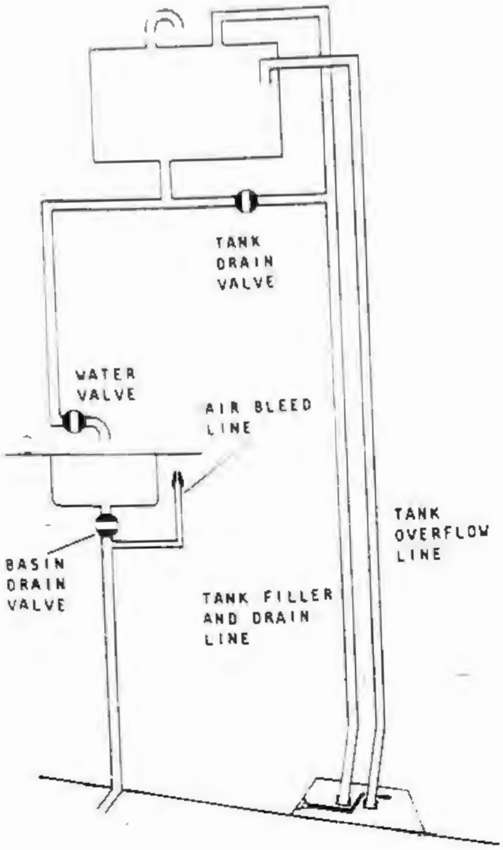
20.5 Motor-Pump-Filter Assembly

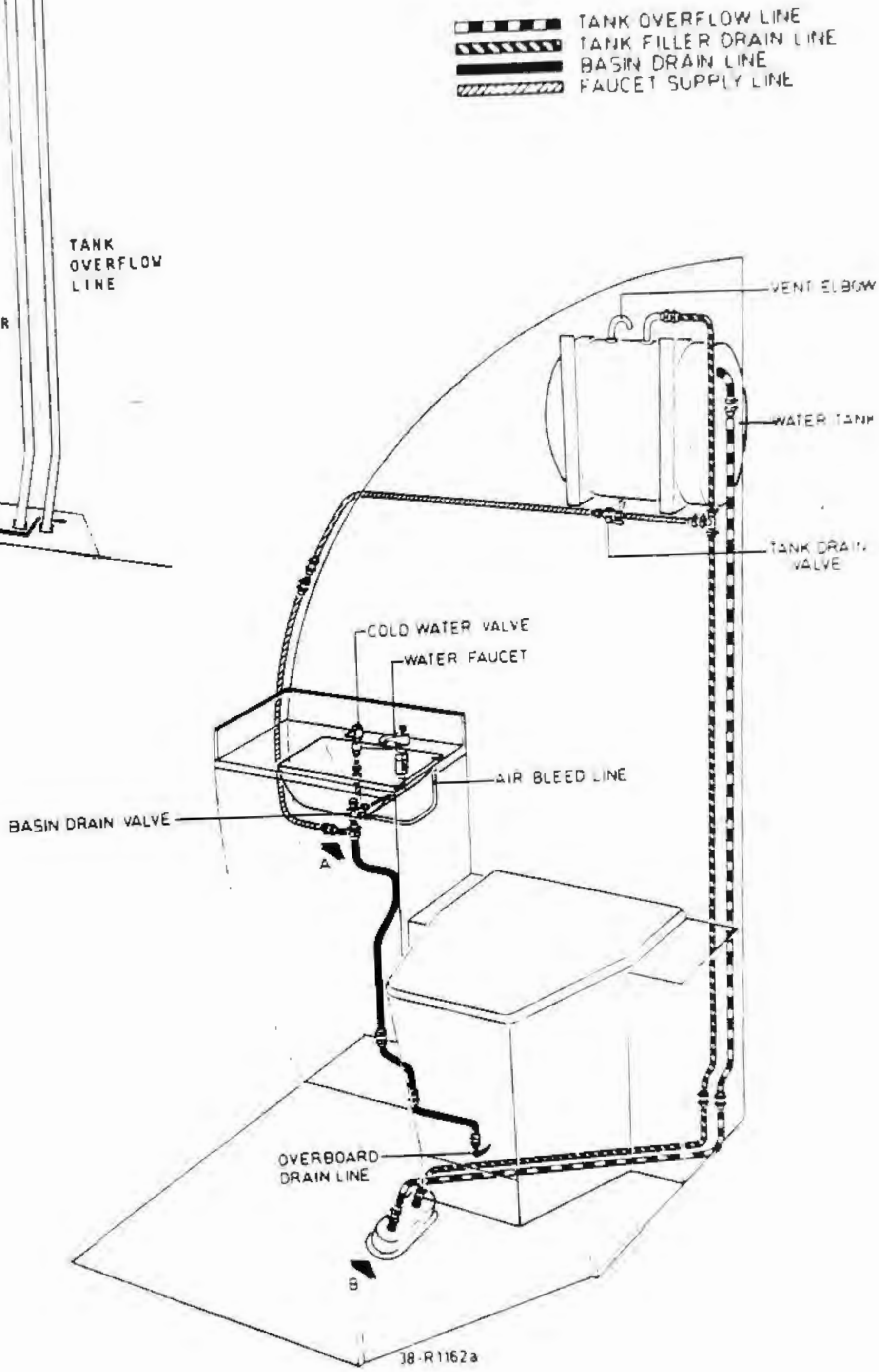
This assembly is located in the waste tank. It consists of a DC motor, an impeller-type pump and a rotating selfcleaning disc-filter. The motor drives the pump by direct coupling and the filter through a reduction gearing.
The pump is a low-pressure high-volume one that delivers flush water to the spray pipe in the bowl.

20.6 Timer Assembly

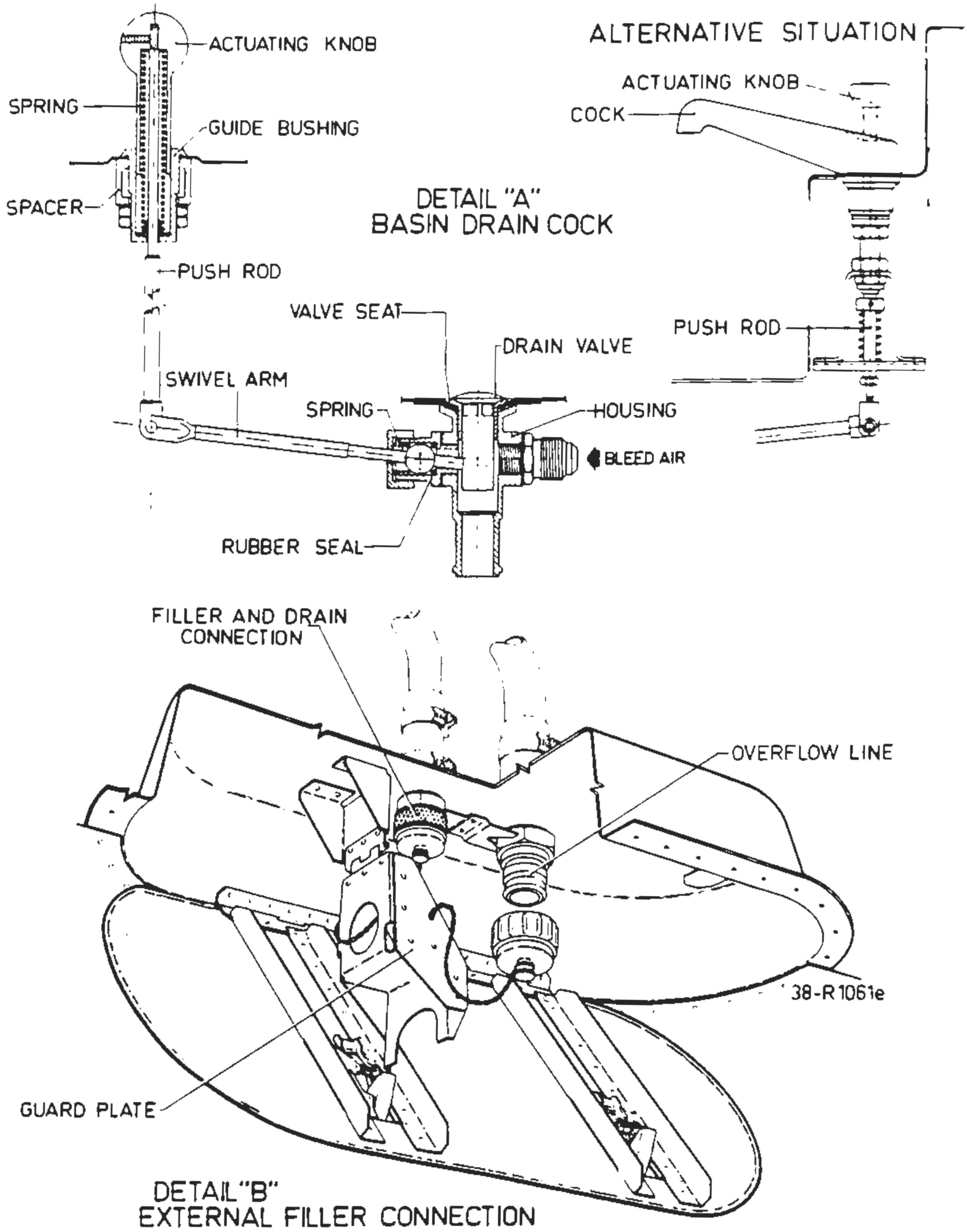
This assembly is a repeat-cycle type, actuated by momentary closing of the switch contacts of the motor-pump-filter assembly.
Each actuation of the flush switch causes the motor-pump-filter assembly to operate for approximately 12 seconds.

END

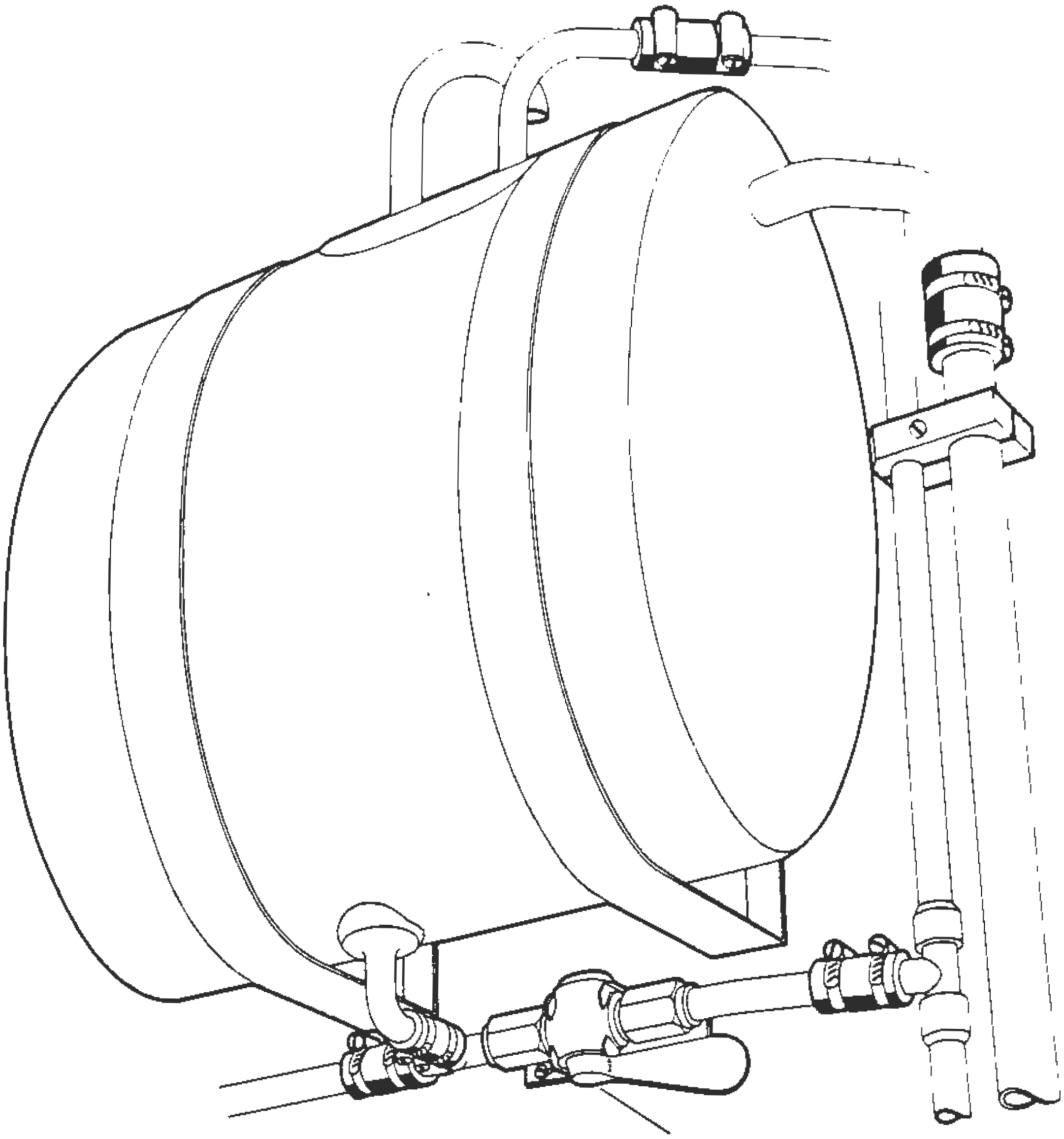




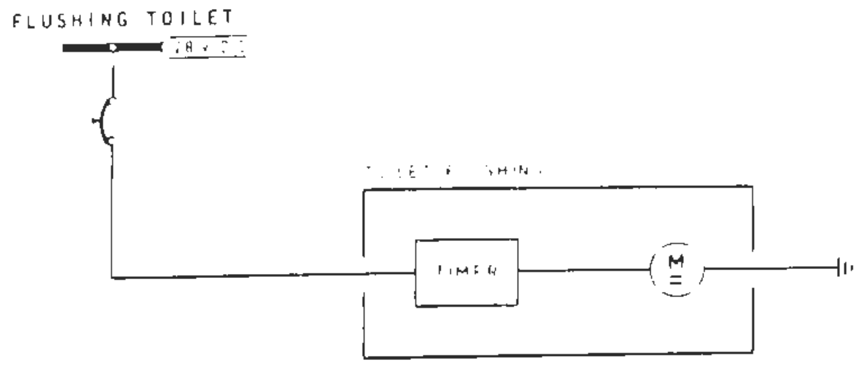
WASH WATER SYSTEM

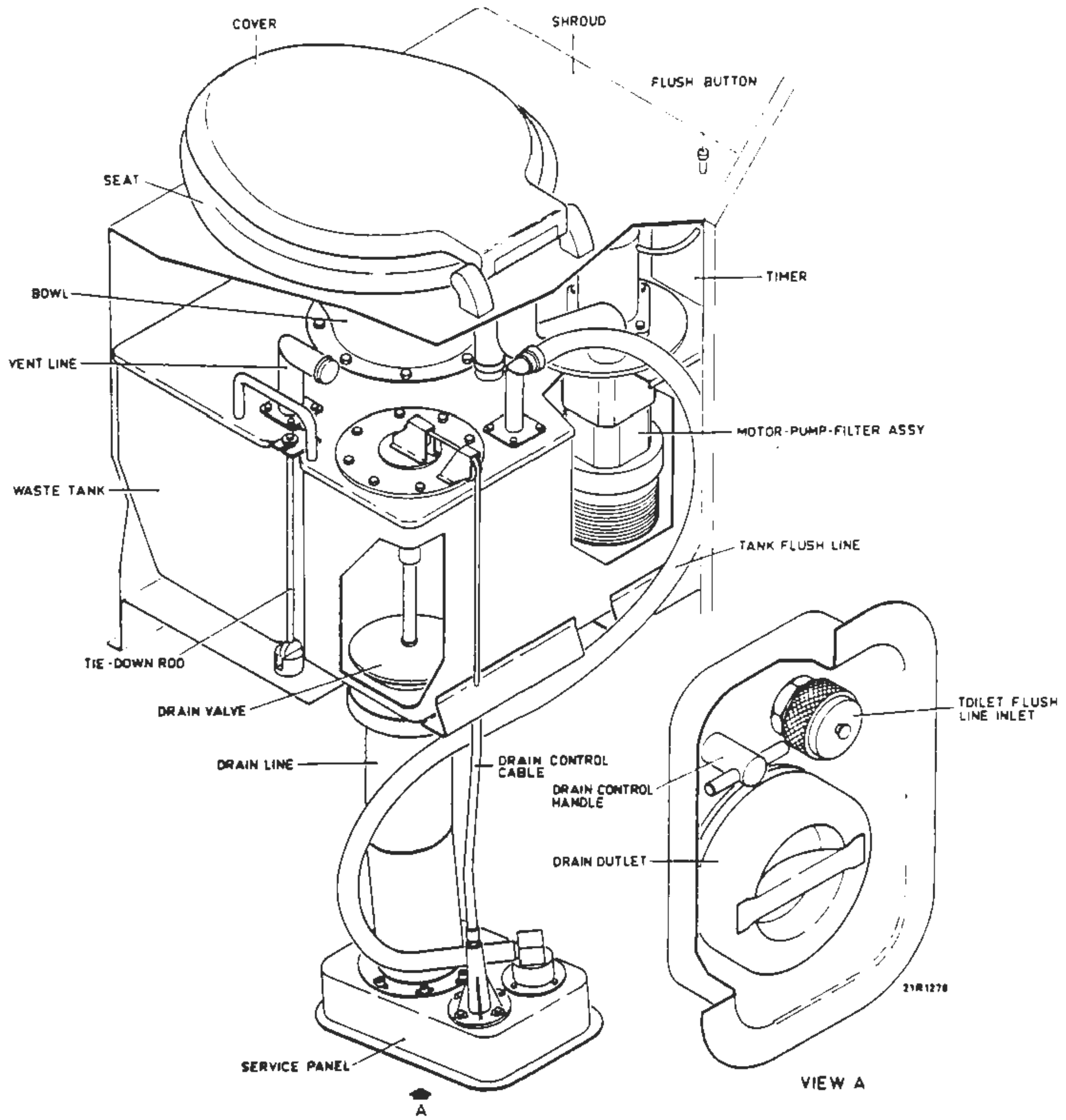


WASH WATER SYSTEM DETAILS



WASH WATER TANK





TOILET AND TOILET CIRCUIT DIAGRAM

STRUCTURES

51

51. STRUCTURES

00. GENERAL

The F27 is an all metal, cantilever high wing aircraft, with a pressurized fuselage of semi-monocoque construction and cantilever empennage.

In general aluminium alloys, in particular 7075, 7079 and 2024, bare and clad are used throughout the aircraft structure.
Normal structural use of aluminium, steel stainless steel, magnesium alloys, fibreglass-reinforced plastic and other approved materials is made.

Redux metal bonding is used to a great extent between stringers and skin of fuselage, wings and empennage.

The adhesive bonding has been combined with a general anti-corrosion treatment. All detail parts of adhesive bonded structures i.e. the greater part of all aluminium alloy structural parts are, after pickling and anodizing and prior to application of the adhesives, coated on all surfaces with a thin layer of adhesive resin which is cured simultaneously with an impermeable resin layer. The structure is further protected against corrosion by draining and ventilating facilities.

Where necessary access is provided by doors, handholes or readily removable parts to facilitate inspection, maintenance and repair.

Structural Data

The F27 differs from conventional aircraft in as much that for large portions of the structure the Redux metal bonding process is used in lieu of normal riveting.
Considerable use is also made of fibreglass-reinforced plastic and sandwich constructions in secondary structures.

A. Metal Bonding

Metal bonding is widely used in thin-walled F27 structures because, when compared with similar riveted structures, there are less stress raisers: sealing operations are simplified, a better strength-to-weight ratio is obtained and the fatigue life is improved. The Redux process can be divided in three phases:

1. Pretreatment
2. Application of the bonding agents
3. Curing

Of the aforementioned phases, the pretreatment is the most important as it is decisive for the adhesive qualities (polarity) of the metal. During the pretreatment the parts to be bonded are completely degreased, pickled and anodized. In the second phase redux liquid and redux powder are applied separately. A mixture of powder and liquid in the form of film may also be used.
In the third phase the parts are assembled and cured at an increased temperature and under pressure. The thermosetting liquid and the thermoplastic powder dissolve mutually and harden, thereby forming a red adhesive layer.

B. Fibreglass-Reinforced Plastics

Fibreglass-reinforced plastics are used in various non-primary structures, such as the radome, nose landing gear doors (Pre S.B. 53-82), fairings

and fillets, air scoops, leading edges of wings and stabilizers, wing trailing edges, hatracks, airconditioning ducts, ice protection plates etc. These parts consist of layers of fibreglass cloth which have been impregnated with synthetic resins and then moulded to a particular contour and cured to a hard consistency.
In addition to having high physical strength, fibreglass-reinforced plastics are light in weight and resistant to water, weather, ageing and a variety of chemicals.
The resins used in F27 production are polyester and epoxy resins. They are thermosetting, polymerisation resins, and curing takes place at room temperature without any pressure.
Polyester resin Lamellon 41 is generally used and is the standard resin for manufacturing those parts which are not subject to special requirements such as heat or fire resistance. Parts made of this resin are transparent and suitable for temperatures up to 100 °C. Some applications are: fillets and fairings, wing tips, outer wing trailing edges, fuselage nose section, radome etc. If fire resistant properties are required, polyester resin Cristic 301 is used. These parts are transparent and are suitable for temperatures up to 75 °C (170 °F).

Some applications are: battery box covers, centre wing trailing edges, hatracks, airconditioning ducts inside the pressure cell, etc. A catalyst and an accelerator are added to the resins according to manufacturers' specification to cure the compound. Curing time can be regulated by varying the quantities of the catalyst and the accelerator, but not more than four per cent by weight of each should be added so as not to affect the properties of the cured resin. The curing time may also be shortened by applying heat.
Epoxy resins are used for those parts which are subject to special requirements such as heat or flame resistance, low shrinkage or a very good adhesion to other materials. The epoxy resins used in F27 production are Araldite F and D.
Araldite F is suitable for manufacturing parts which are subject to heat up to 150 °C or which are to be bonded to other materials. Some applications are: airconditioning ducts outside the pressure cell, nacelle tail cones, and the leading edges of wing and stabilizers. Mixed with mica powder it can also be used for bonding of heat resistant plastic parts. Parts made of Araldite F are brown in colour.
Araldite D is used for bonding of polyester or as a filling agent and is to be mixed with mica powder to obtain the correct properties. In addition it is used for repair of the plastic leading edge skin. To set off curing only a hardener is added according to the manufacturers' specifications. The amount of hardener needed for a certain quantity of resin has a definite value. When too little or too much hardener is added, the resin will cure badly or not at all. To accelerate the curing time heat is usually applied.

C. Sandwich Structures

Sandwich structures are used in some metal bonded assemblies, e.g. the standard cabin floor panels, as well as in some reinforced plastic constructions e.g. wing and stabilizer nose sections, and wing trailing edge sections. The core material used is aluminium hexagonal honeycomb. In the wing trailing edge expanded ebonite is used as a core material.

D. Surface Protection

The nonclad aluminium alloy skin surfaces are generally protected against corrosion by means of anodizing and thereafter by a single coat of paint. Exterior surfaces and surfaces extremely exposed to corrosion e.g. bottom

structure of the fuselage and battery boxes, are protected by several layers of paint.

E. To obtain a good pressure sealing, all riveted joints in the pressurized area of the fuselage are sealed with a synthetic rubber sealing compound. In the integral fuel tanks sealing is similarly obtained; an additional protective coating is applied over the complete internal tank area.

END

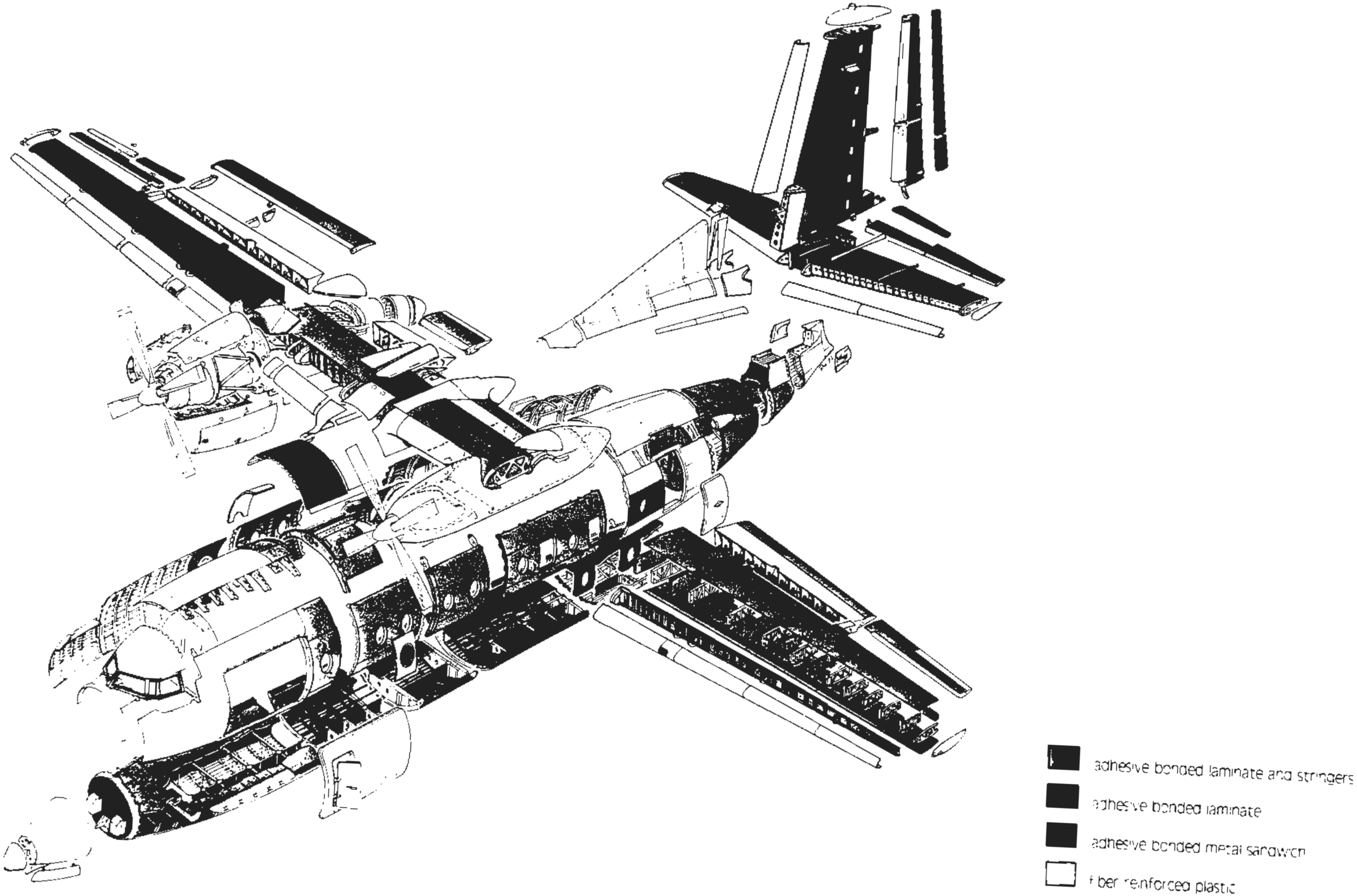
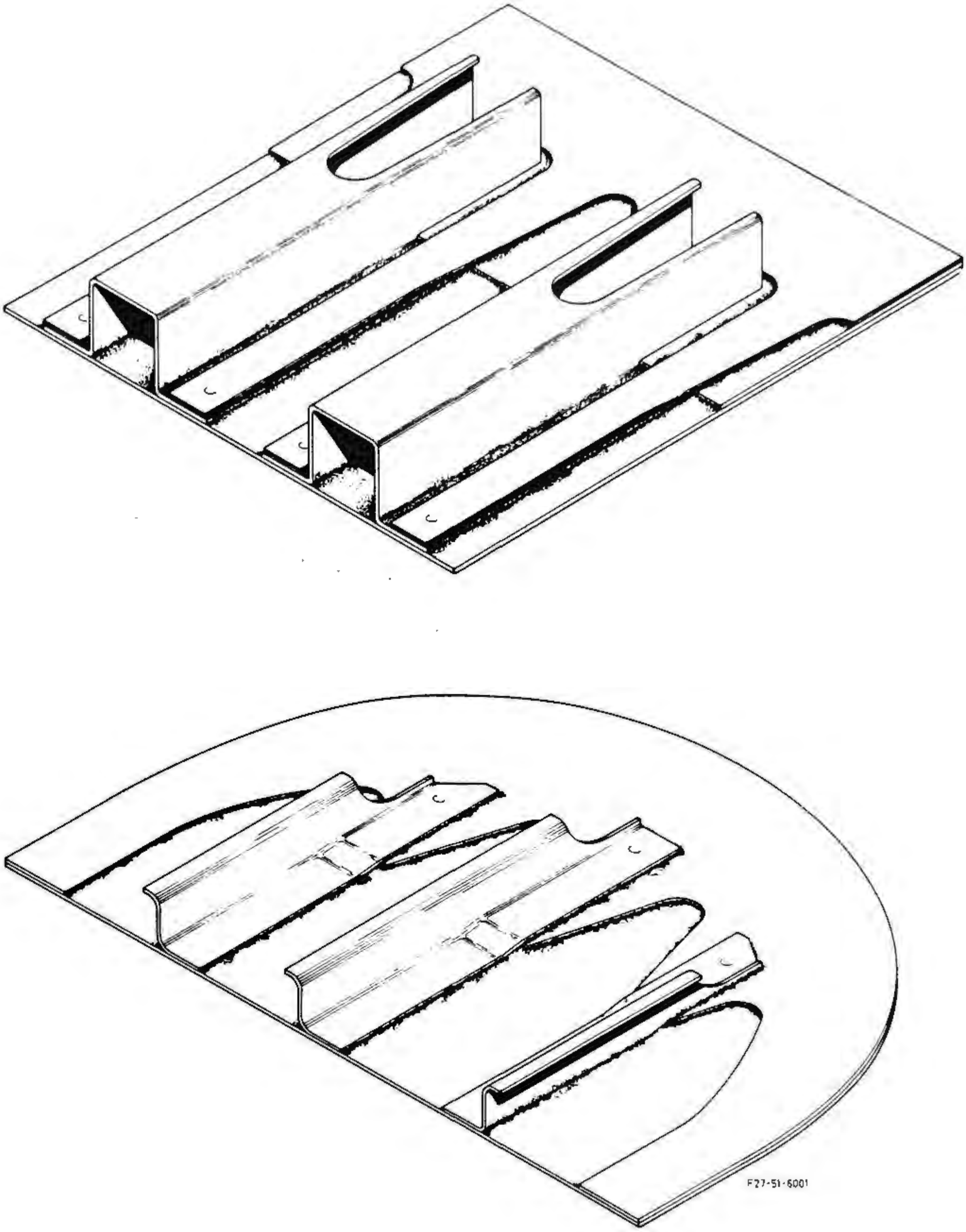
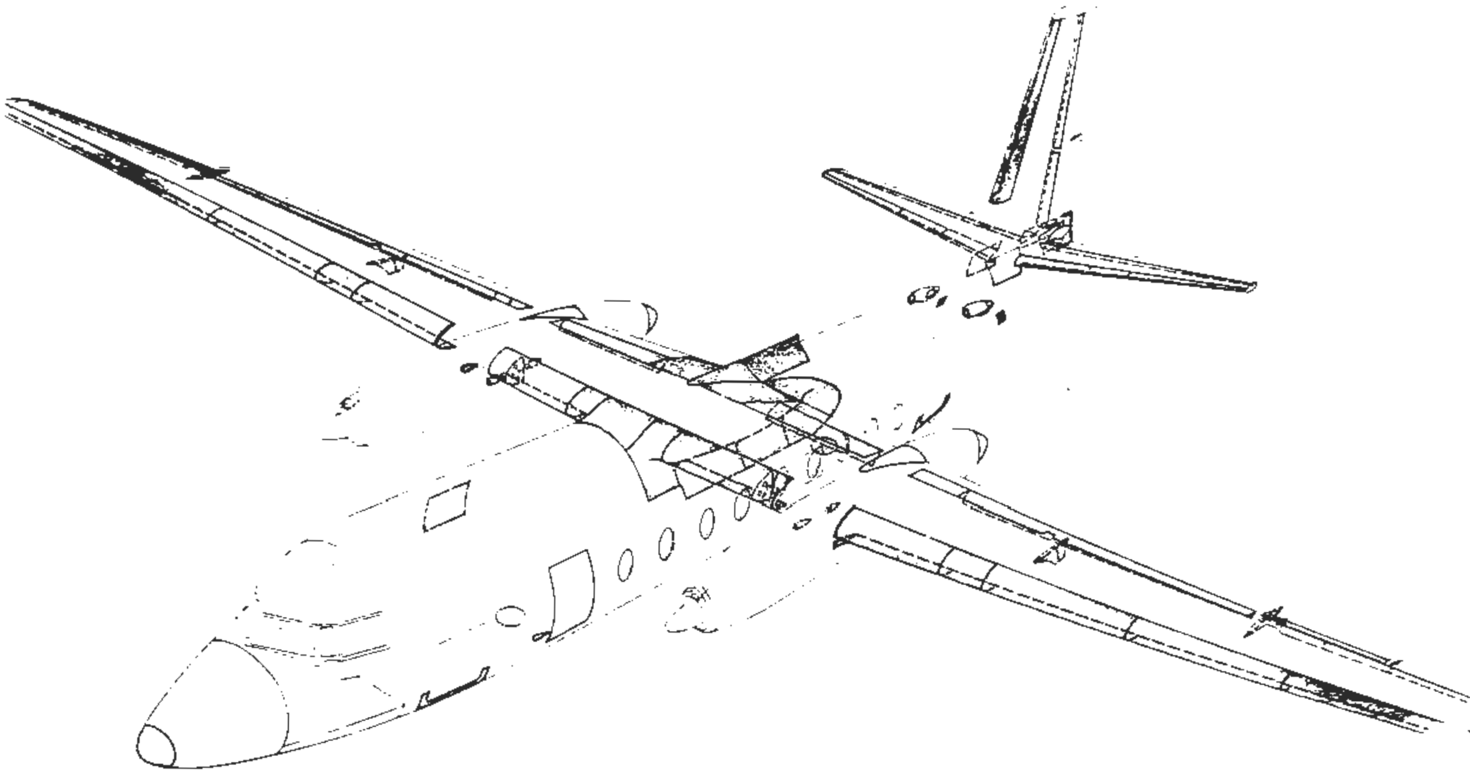


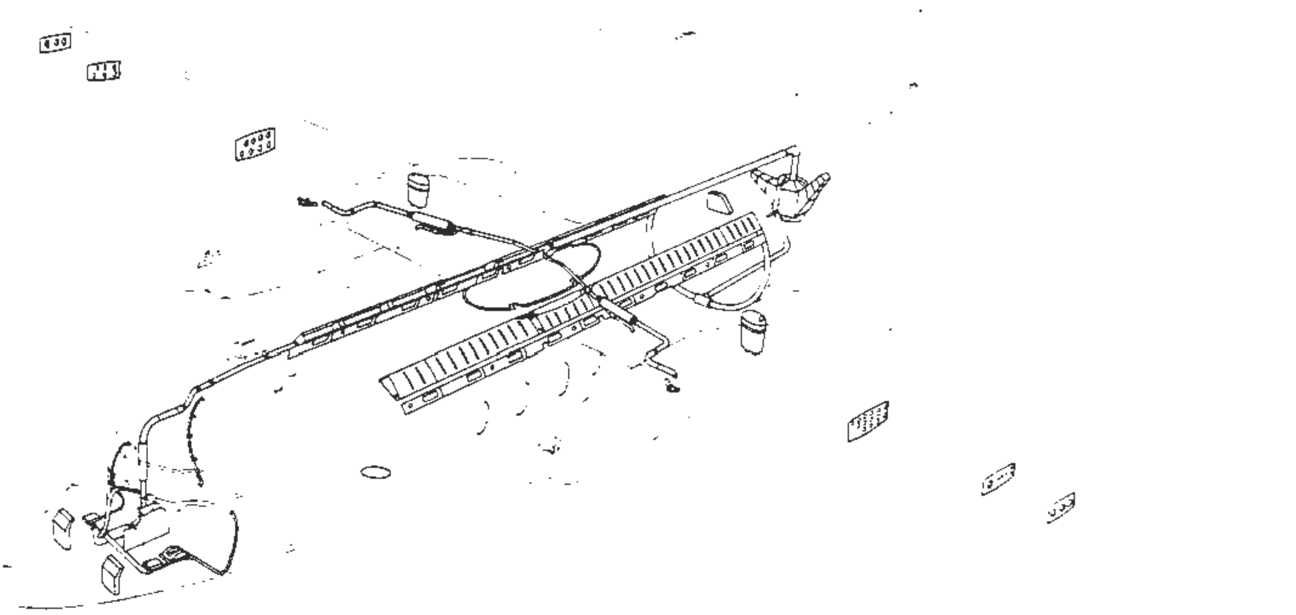
ILLUSTRATION SHOWING THE EXTENT OF METAL BONDING AND USE OF COMPOSITES IN F27 AEROPLANES.



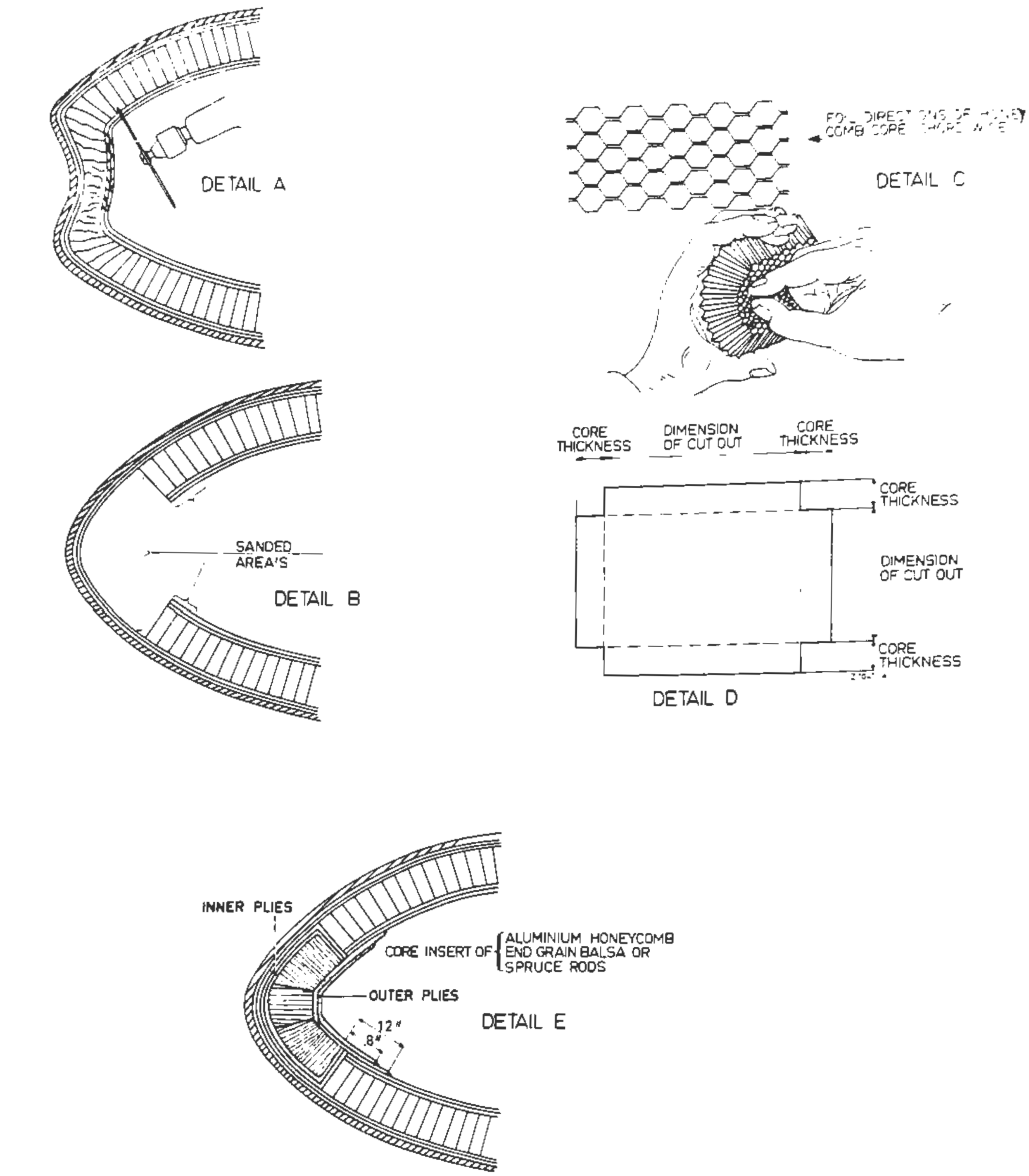
BONDED STRUCTURE



MAIN PLASTIC PARTS ON THE OUTSIDE OF THE AIRCRAFT



MAIN PLASTIC PARTS INSIDE THE AIRCRAFT



REPAIR OF LEADING EDGE SECTION

52. DOORS

10.0 PASSENGER DOOR

The passenger door is located on the LH side of the rear cabin and is of an all metal structure. The door is hinged at the bottom to a guide tube assembly which can slide aft over roller blocks fitted to the floor structure between the fuselage skin and an auxiliary wall. When the door is moved to the full open position, a roller assembly fitted at the top of the door engages a track fitted to the auxiliary wall.
A tubular seal is fitted to the door by means of an aluminium retainer and screws.

10.1 Locking Mechanism

The door locking mechanism extends through the middle of the door and consists of an actuating shaft sliding along a splined actuating bushing. The actuating bushing is housed in a retainer, riveted to the door structure.

The actuating shaft is provided with an external operating handle, which, when raised to the horizontal position, pulls the shaft outwards against the action of a compression spring. As a result a locking pin, fitted to the actuating shaft, is withdrawn from the fully closed position hole in the handle housing, allowing the handle to be rotated 45 degrees in counterclockwise direction. In this position the locking pin automatically engages an open position hole in the handle housing when the actuating shaft is pushed in by the action of the compression spring, after the handle is released.

The door is unlocked from the inside by pressing the actuating shaft extending through the centre of the internal operating handle and by rotating the handle in clockwise direction.

When the handle is rotated, a bell crank attached to the actuating bushing operates three locking pins on each side of the door through adjustable push-pull rods and levers. Guide fittings bolted to the door structure guide the locking pins.

To lower the forces required to operate the passenger door a balance device is installed on the lower side of the door.
Between 2 brackets, mounted on the inside of the door, a spring-loaded door hinge bracket is installed. The hinge arms on either end of the bracket have on the lower end a provision for supporting the door on the guide tube and a cam which will engage with a slotted disc which can rotate in the roller housing mounted on the guide tube. This allows the door to be lifted from the guide tube only when the door is unlocked and the emergency release mechanism is operated.

10.2 Emergency Release Mechanism

The emergency release mechanism consists of a cable pulley with a cable connected to a roller assembly.

A torsion spring tends to wind the pulley. However, winding is prevented by a grooved lock pin, locked in position by a spring-loaded ball in such

00. GENERAL

This chapter deals with the description and operation of all doors which provide access to the pressurized compartment.
Also covered are the landing gear doors and door light system.

The doors in the pressurized area, with the exception of the cargo door in the front of the cabin are plug-type doors. They open inwards.
Each door in the pressurized area is provided with a pressure seal and an insulation lining installed on the inboard surface of the doors.

The passenger door is located on the LH side of the rear cabin. It can be opened from both inside and outside by handles, which actuate the door locking mechanism. After unlocking, the door is moved inwards and then pushed rearwards.

An emergency door is located on the RH side of the rear cabin. It can be opened and removed from both inside and outside.

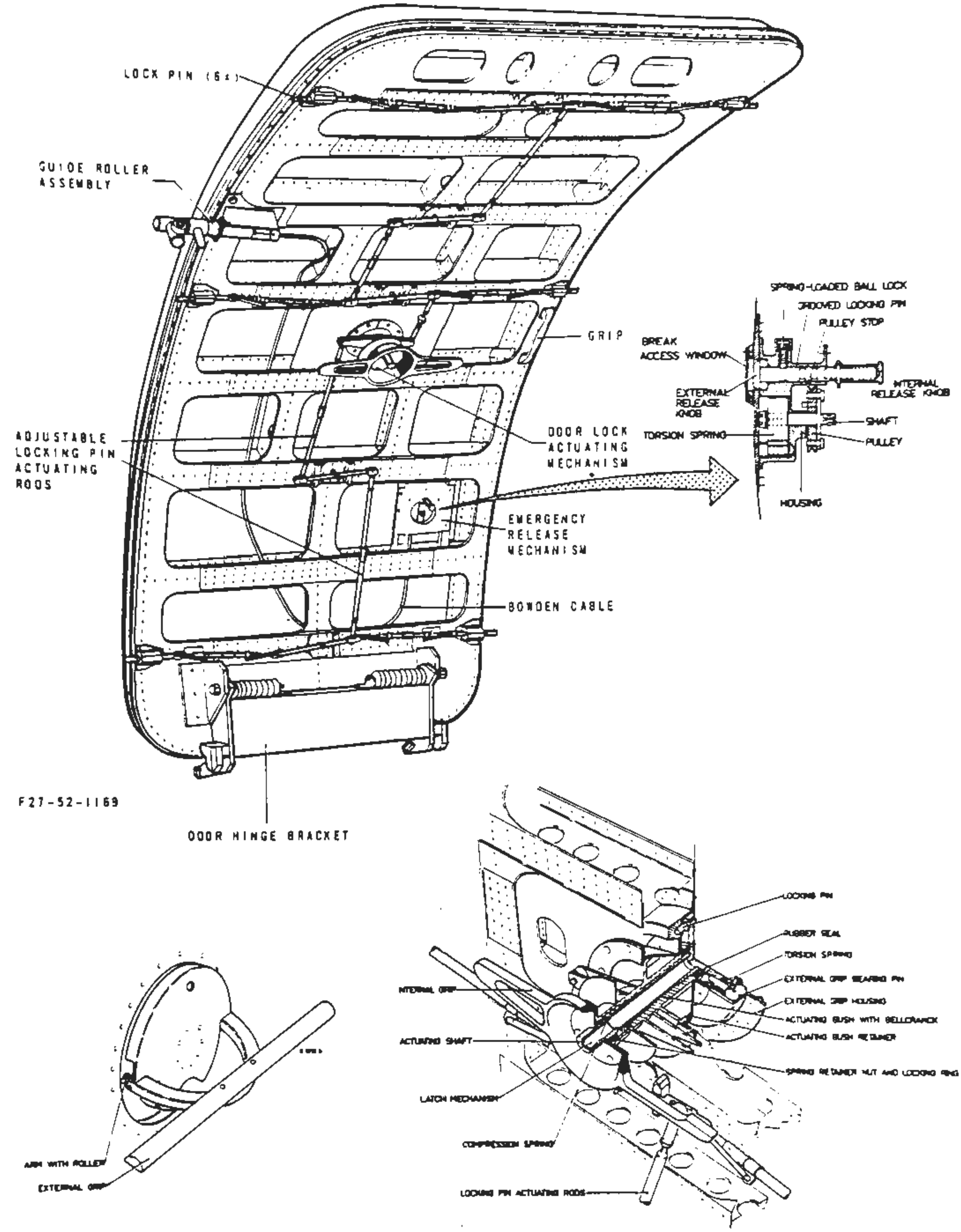
The cargo door in the front of the cabin is an electrically operated outward-opening door. The door is provided with a small crew door which can be opened from either inside or outside.
The cargo door can only be unlocked from the inside by unlocking the latches after which the door is electrically operated.
The door can be manually opened in case of an electric failure.
A cargo door light in the cockpit gives the crew a visual indication of an incorrect-closed cargo door or crew door.

Emergency escape hatches are installed in the cabin. They can be opened from the inside as well as from the outside of the aircraft.

Each main landing gear is provided with a small front door, two centre doors and two aft doors.

The nose landing gear is provided with two doors hinged to the fuselage nose section.

END



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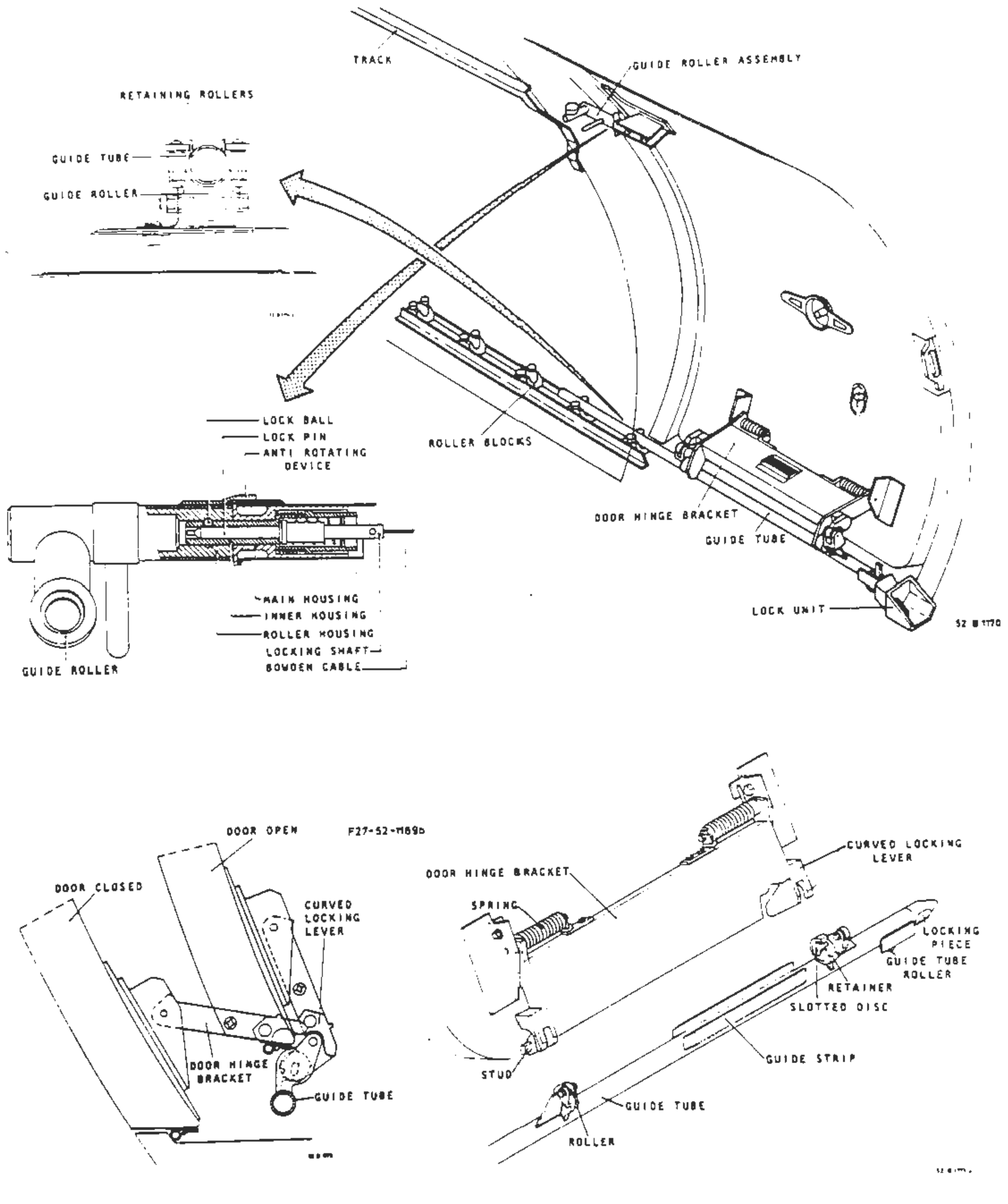
PASSENGER DOOR



PASSENGER DOOR MECHANISM DETAILS

20.0 EMERGENCY EXITS

20.1 Emergency Door

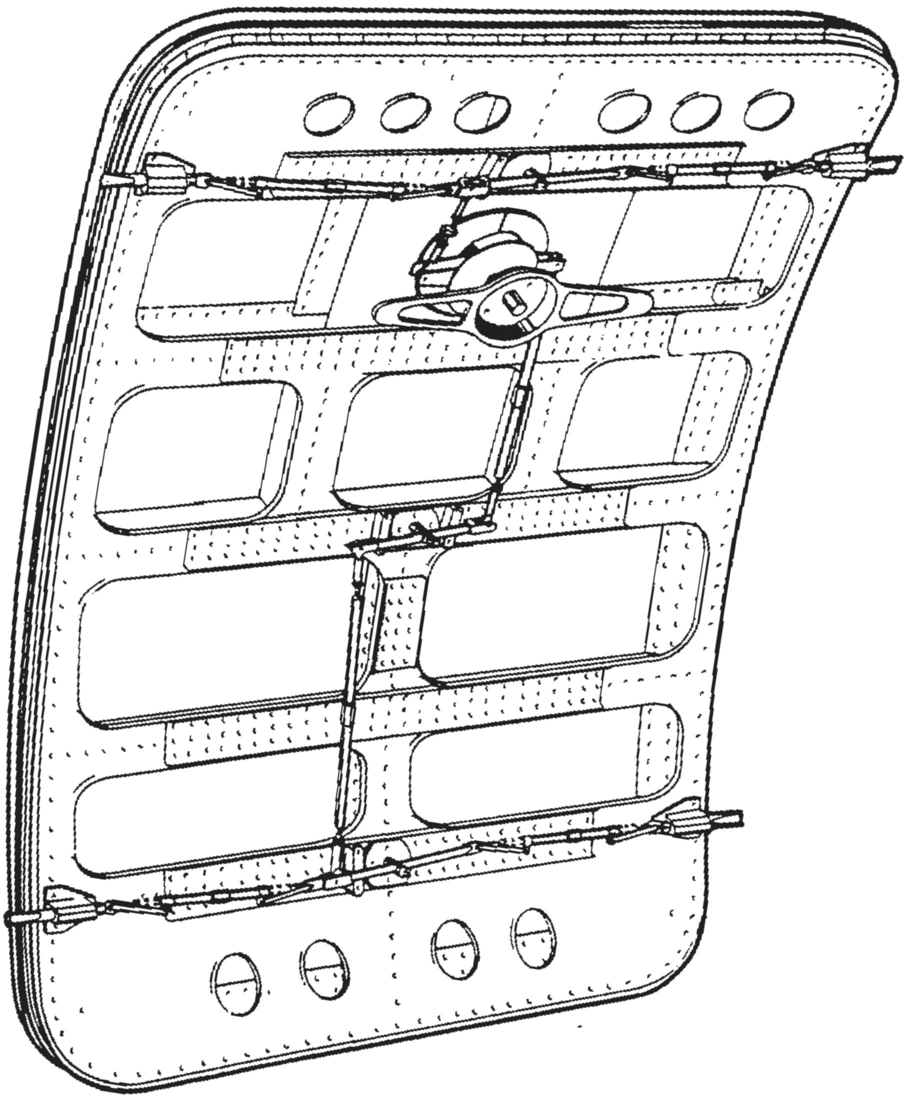
The emergency door, located at the RH side of the rear cabin, opens inwards. The all-metal door is unlocked by rotating either inside or outside door handle, which operates identical as the passenger door handle.
Inadvertent unlocking of the door from the inside is prevented by a break access window over the knob in the centre of the handle.

20.2 Emergency Escape Hatches

Emergency escape hatches are provided on each side of the cabin and can be opened from the inside and outside.

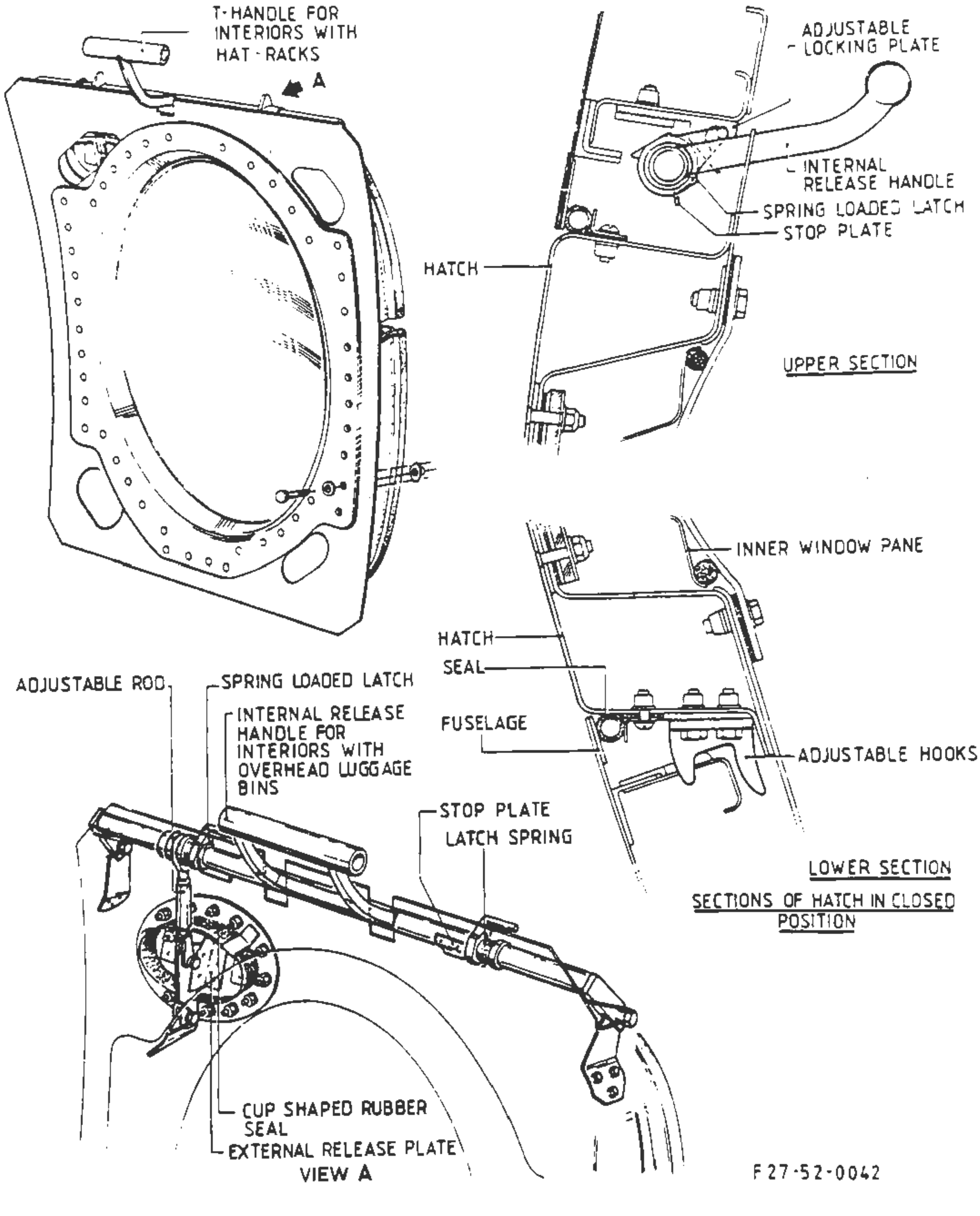
Each hatch is retained against inward acting loads by two hooks on the bottom edge of the hatch and a latching mechanism on the top. The bottom hooks fit into holes in two fittings in the hatch frame. The latching mechanism at the top of the hatch consists of an interior recessed handle attached to a spring-loaded horizontal actuating tube and two spring-loaded latches. The latches will engage two adjustable latch fittings secured to a beam at the top of the hatch opening.
An external release plate is provided on the outside of the hatch to open it from the outside.

END



EMERGENCY DOOR

CODE 6



EMERGENCY ESCAPE HATCHES

30.0 CARGO DOOR

The large outward-opening cargo door of an all-metal structure, is located on the LH side of the cabin. A smaller door incorporated in the cargo door is used as a crew door and as an emergency exit. The cargo door is at the upper edge attached to the fuselage by means of a piano hinge. The hinge pin consists of two parts, locked by stop nuts in the centre of the hinge.
At the lower edge of the door five latch assemblies are bolted to heavy angles, which in turn are riveted to the door frames. Each latch assembly consists of a hook, link, knee-lever and an adjustable operating rod fitted between two brackets. Each operating rod is connected to an operating lever of a locking bar running along the full width of the door. The locking bar can only be operated from the inside of the aircraft, by means of an operating lever near the second latch from the front. When the door is closed and latched the lever is locked under the springloaded cup of the locking handle.

A support strut, hinged to a fitting at the aft end of the door, is stowed to a bracket on the inner surface of the door by means of a wing-bolt.
The wing-bolt is also used to attach the strut to a fitting on the fuselage outside, when the door is in the half-open position.

The outward opening crew door is hung on two external hinges on its forward edge. The hinge halves are provided with slotted holes to allow inward movement to the sealed position when the door is locked.
Two handles are bolted to the centre torque tube, one on the inside and one on the outside of the door to operate the door locking pins.
A recess in the aft locking pins prevents inadvertent unlocking of the door when the cabin is pressurized. The recess has passed the roller in the lock fitting when the door is closed, requiring a considerable force to withdraw the lock pins from this position.

The cargo door is opened and closed by means of an electric actuator and a drive mechanism.
The actuator is controlled by three push-button switches located on the aft face of the main junction box, marked: OPEN, HALF OPEN, and CLOSED.
Limit switches incorporated in the drive system allow the door to be opened through 110 degrees (HALF OPEN) or 170 degrees (OPEN).

Safety switches are incorporated in the door control circuit to prevent operation of the actuator when:
a. the cargo door is latched.
b. the crew door is unlocked.
c. the support strut is not properly stowed.

Actuator Mechanism

The actuator is bolted to the upper bearing housing and incorporates a small 24-Volt DC motor, a clutch and a three-stage epicyclic gear train. The clutch is set to slip under excessive loads, thus preventing damage to the actuator or drive mechanism.

A brake mechanism is fitted between clutch and gear train. The brake is released by an electro magnet.
The gear train produces the necessary reduction in speed from the motor to the drive shaft. The final annular gear is locked to the actuator housing by means of a conical release pin, which is locked in position by a spring-loaded release plunger. When the release mechanism is operated, the final annular gear is free to rotate, allowing the drive shaft to become free.
When the release mechanism is allowed to run back into position, the release pin is brought into engagement with a cam face on the final annular gear, thus keeping it rigid for transmitting drive to the drive shaft. The actuator is designed for intermittent duty only and a cooling period of five minutes after one complete open/close operation should be allowed.

Release Mechanism

The mechanism consists of a ratchet-type control lever installed on the main junction box, just below the door selector switches, a spring-loaded intermediate lever mounted to the fuselage frame on the top of the main junction box, and two Bowden cables. The lever has two positions, marked ELECTRIC and DECLUTCHED, and is locked in the ELECTRIC position by means of a guard.
The guard is hinged to the main junction box and locked in position by a splitpin which is provided with a ring for easy withdrawal. Moving the control lever from ELECTRIC to DECLUTCHED will pull the Bowden cable and retract the spring-loaded release plunger of the actuator, allowing the release pin to disengage the final gear from the actuator housing, thus freeing the final annular gear. If the control lever is allowed to return to ELECTRIC, the release plunger will return to its original position under spring tension.

CAUTION: 1. IF THE DOOR IS IN THE OPEN POSITION, IT SHOULD BE SUPPORTED BEFORE DECLUTCHING BY MEANS OF THE DOOR SUPPORTING STRUT OR SAFETY CLAMP.
2. NEVER MOVE THE CONTROL LEVER FROM "DECLUTCHED" TO "ELECTRIC" WHEN THE ACTUATOR IS RUNNING, OTHERWISE DAMAGE TO RELEASE PIN AND CAM FACE WILL OCCUR.

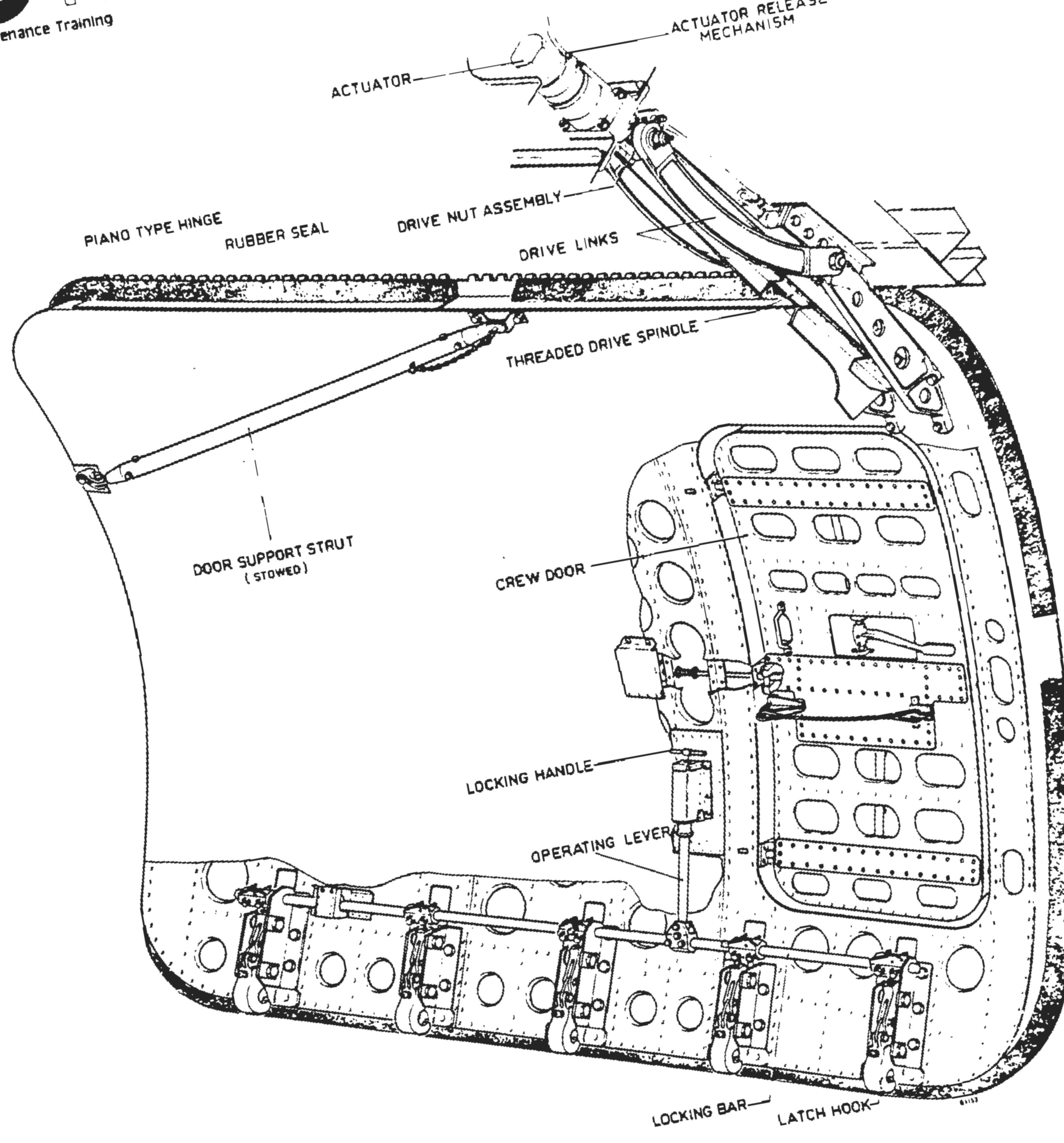
Drive Mechanism

The drive mechanism consists of two arched drive links, swivel-mounted to door brackets on one end and to the trunnions of a drive nut assembly on the other end.
The drive nut assembly is driven by a spindle and moves inside a track formed by two heavy T-sections which are secured to the fuselage. During movement, the assembly is guided by a roller assembly fitted to the trunnion on each side of the drive nut. In the event of electrical failure of the open limit switch the door will be stopped by a mechanical stop. The drive spindle rotates in an upper and lower bearing housing bolted to the ends of the track, the loads being taken up by two thrust bearings and a ball bearing fitted in the lower housing and a plain bearing fitted in the upper splined drive shaft of the actuator.

Safety Clamp

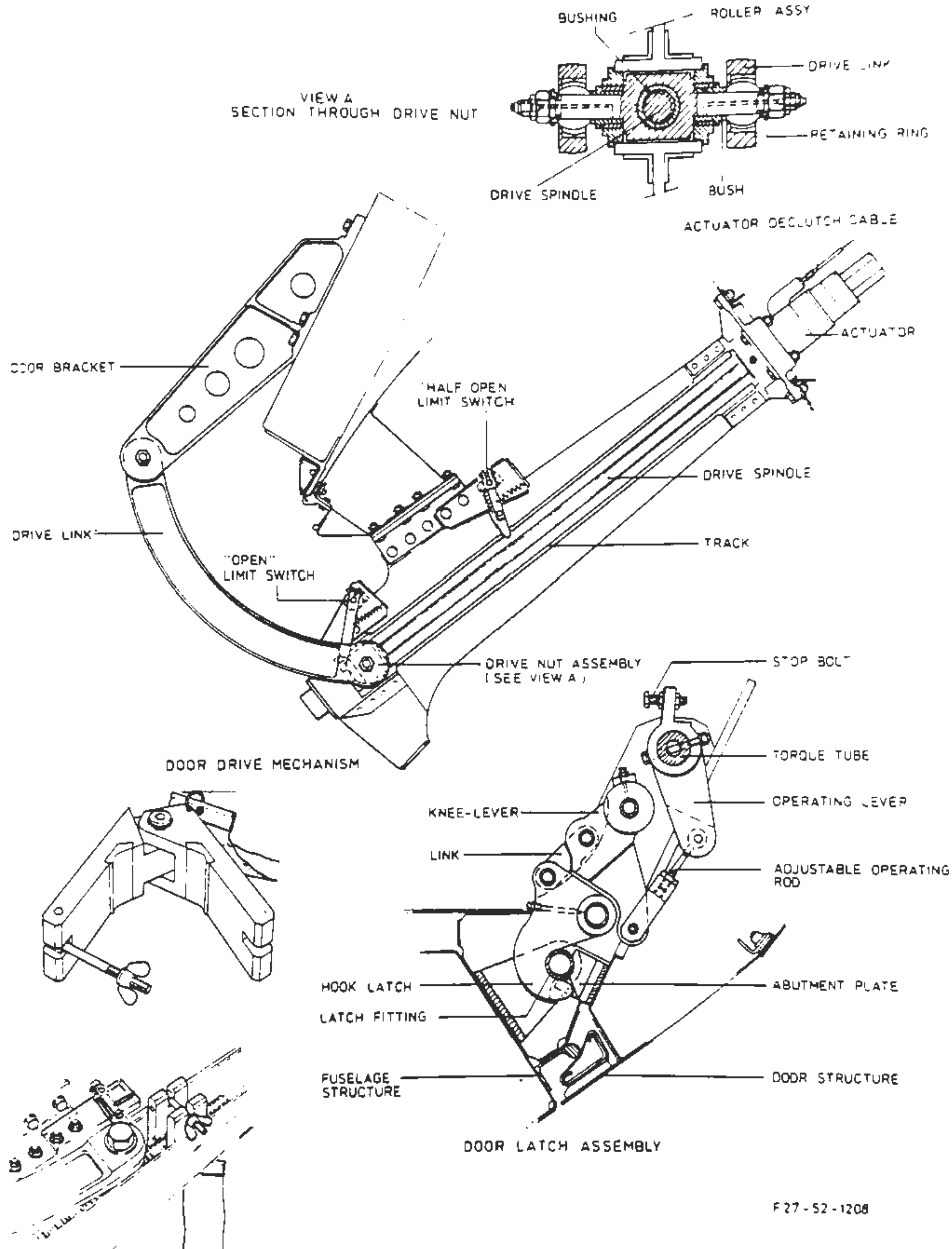
When the door is in the full open position, a safety clamp can be installed. Place the legs of the clamp between the track and the drive spindle and clamp by means of the retainer bolt and wing nut.

END

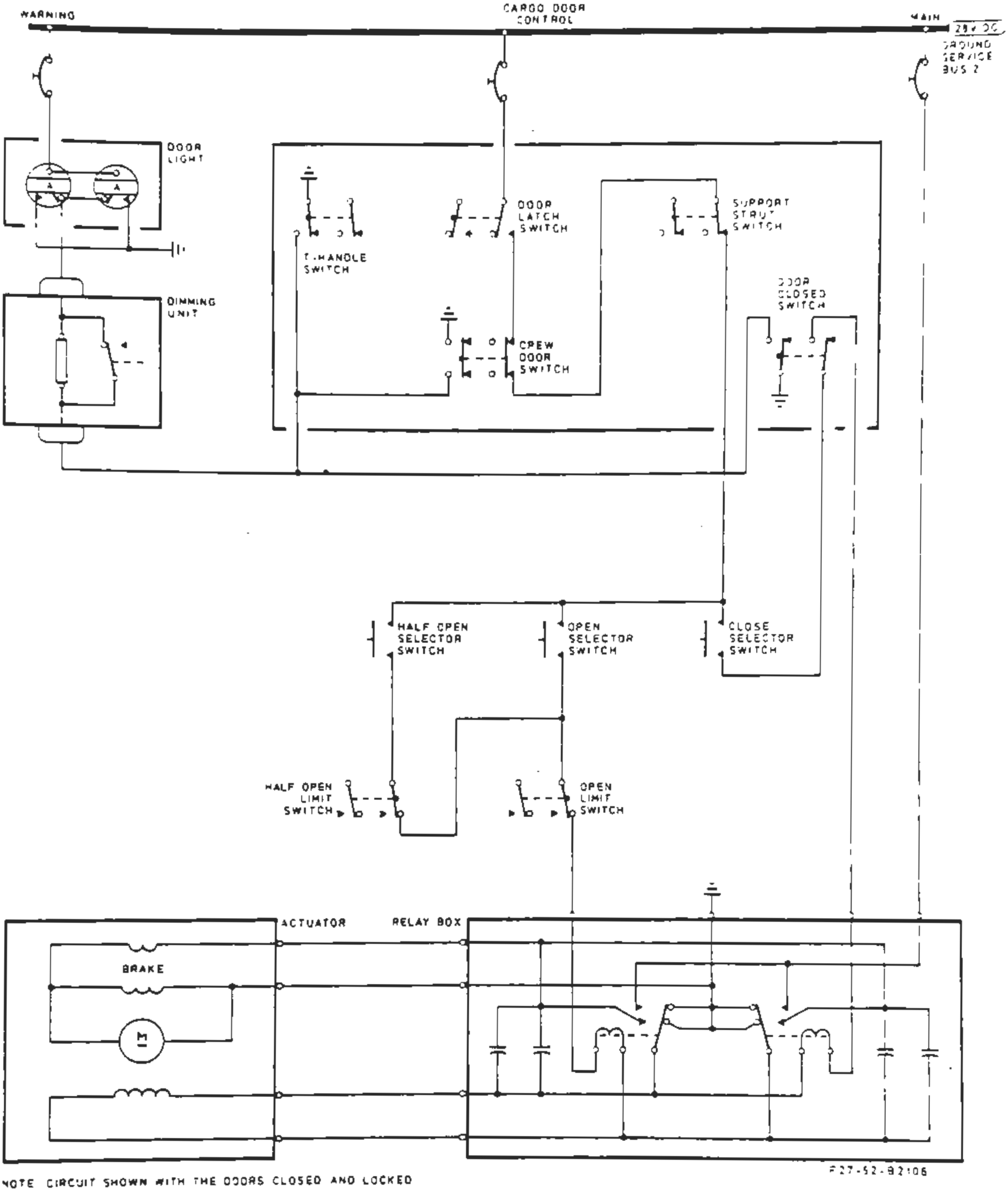


CARGO DOOR 1

CODE 6


BUSHING
ROLLER ASSY
DRIVE LINK
VIEW A
SECTION THROUGH DRIVE NUT
RETAINING RING
DRIVE SPINDLE
BUSH
ACTUATOR DECLUTCH CABLE
ACTUATOR
DOOR BRACKET
HALF OPEN
LIMIT SWITCH
DRIVE SPINDLE
DRIVE LINK
TRACK
"OPEN"
LIMIT SWITCH
DRIVE NUT ASSEMBLY
(SEE VIEW A)
DOOR DRIVE MECHANISM
STOP BOLT
TORQUE TUBE
KNEE-LEVER
OPERATING LEVER
LINK
ADJUSTABLE OPERATING ROD
HOOK LATCH
ABUTMENT PLATE
LATCH FITTING
FUSELAGE STRUCTURE
DOOR STRUCTURE
DOOR LATCH ASSEMBLY
F27-52-1208

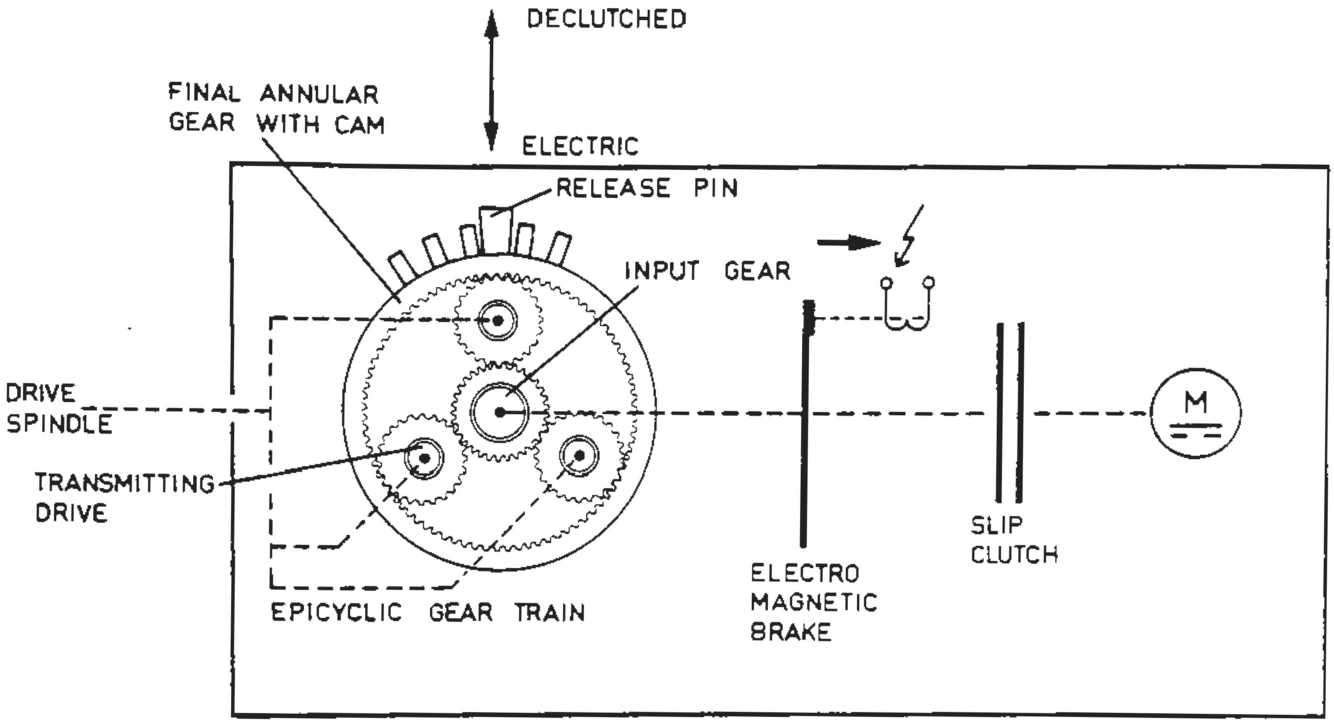
CARGO DOOR 2



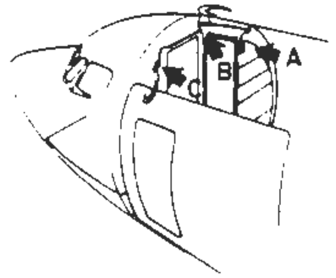
NOTE CIRCUIT SHOWN WITH THE DOORS CLOSED AND LOCKED

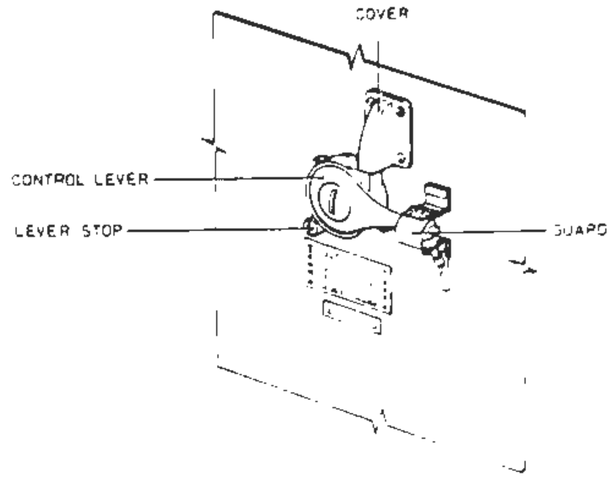
CARGO DOOR CONTROL CIRCUIT

CODE 6

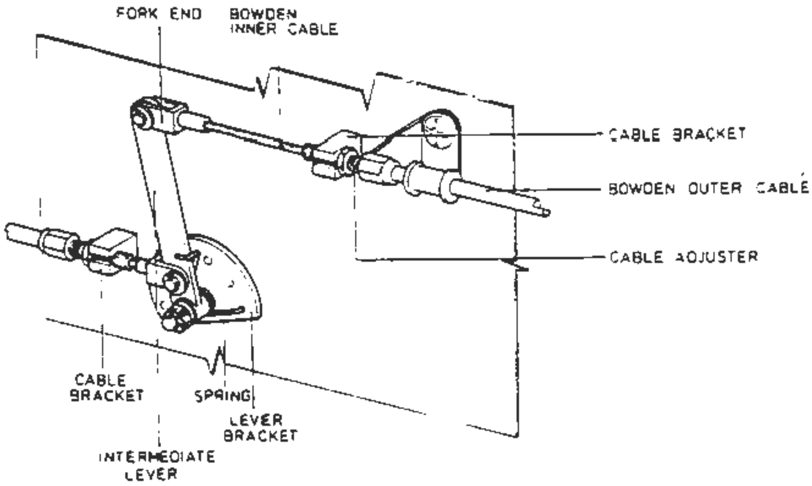

DECLUTCHED
FINAL ANNULAR
GEAR WITH CAM
ELECTRIC
RELEASE PIN
INPUT GEAR
DRIVE
SPINDLE
TRANSMITTING
DRIVE
EPICYCLIC GEAR TRAIN
ELECTRO
MAGNETIC
BRAKE
SLIP
CLUTCH
M

ACTUATOR

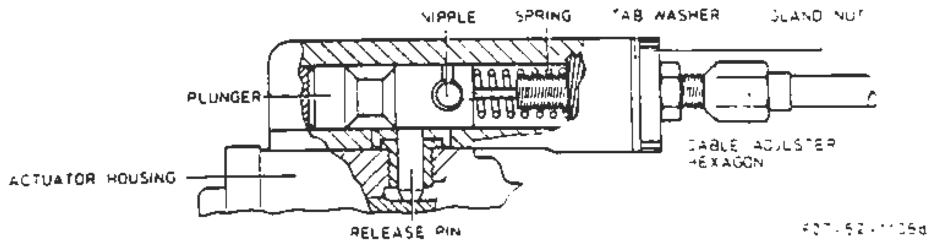




VIEW A
CONTROL LEVER INSTALLATION

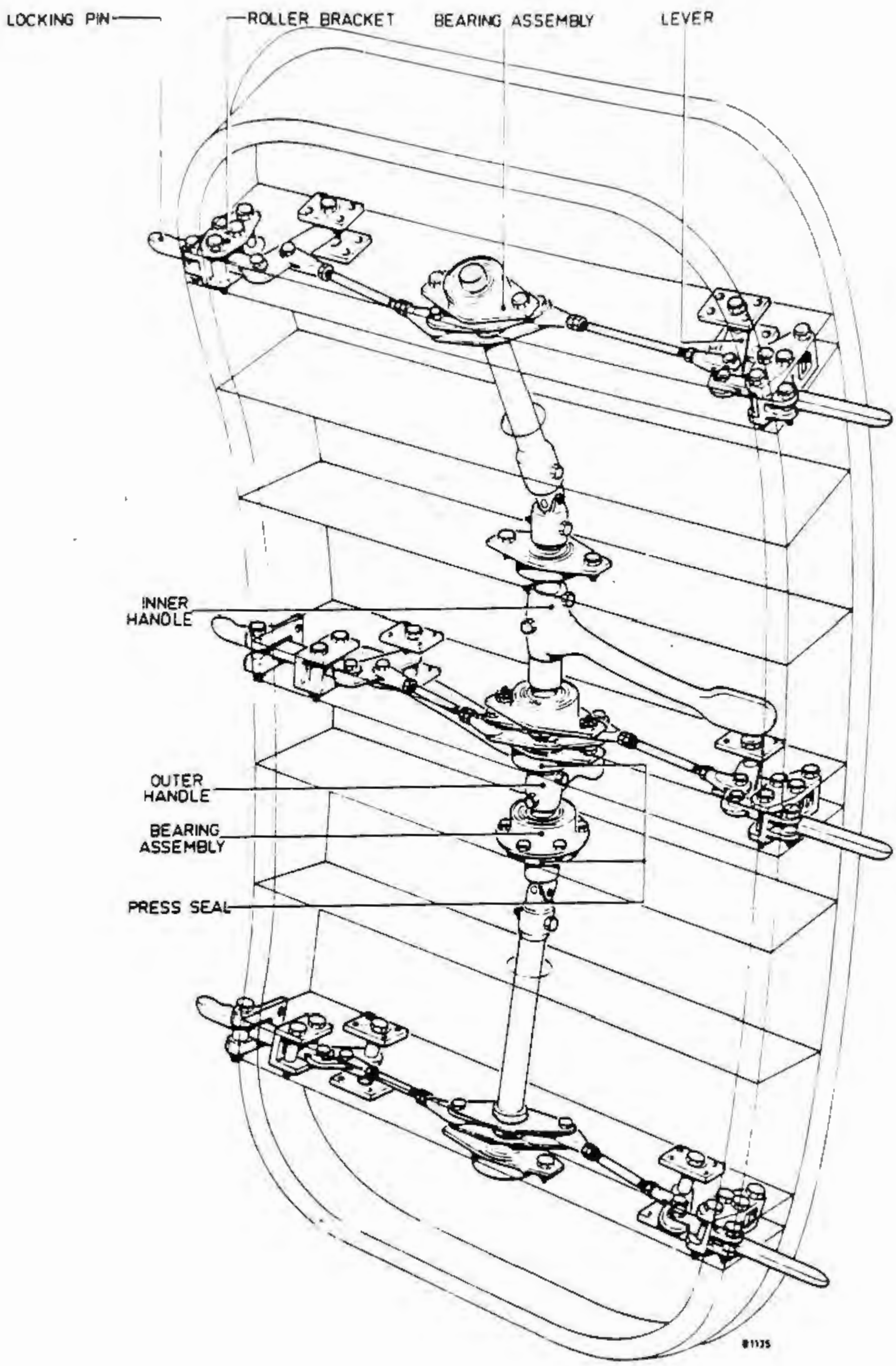


VIEW B
INTERMEDIATE LEVER ASSEMBLY



VIEW C
ACTUATOR DECLUTCH

ACTUATOR RELEASE MECHANISM



CREW DOOR

CODE 6

80. LANDING GEAR DOORS

80.1 Nose Landing Gear Doors

Two, flush fitting, metal doors completely close the opening for the nose landing gear when retracted. A hinge arm provided with a plain bearing is mounted to a bracket on the front and rear of each door.
The hinge arms both pivot on bolts, attached to mountings on the nose section. The doors are actuated by rods, swivel-mounted on the aft door bracket.

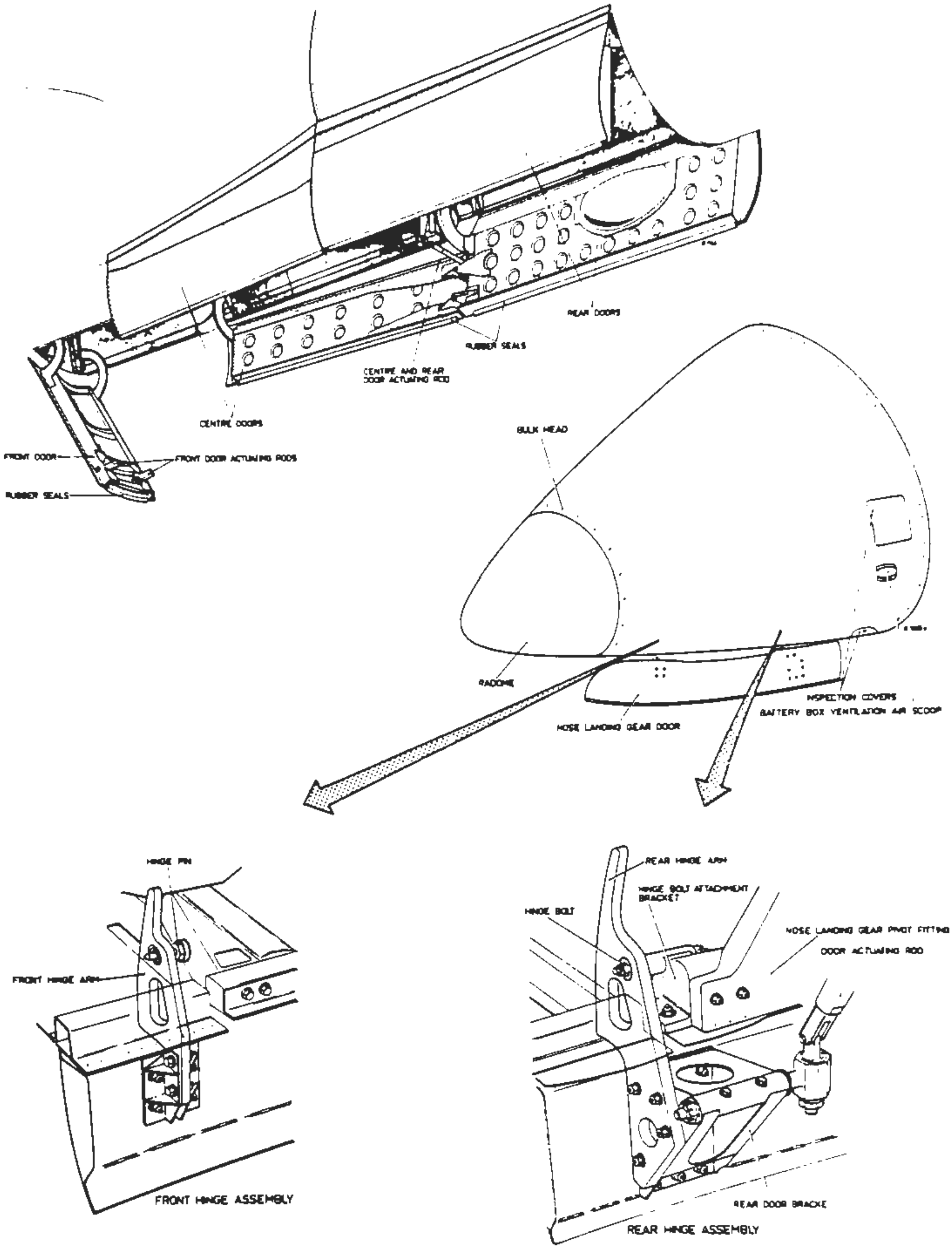
80.2 Main Landing Gear Doors

The main landing gear doors consist of a small front door, two centre and two aft doors. The front door is hinged to two brackets on the nacelle and braced to the drag strut of the main landing gear. In the closed position the door closes the gap forward of the centre doors.

The centre and aft doors are hinged to brackets riveted to the nacelle structure and are interconnected by a hinge mounted in between each centre and aft door.

Both pairs of centre and rear doors are actuated by links connecting the rear doors to carriages and spring-loaded latch assemblies, which roll on vertical T-beam tracks.

END



LANDING GEAR DOORS

a way, that a stop on the pulley abuts the lock pin between the grooves. The lock pin can be operated from either side of the door and operation in either direction causes the pulley stop to slip through one of the grooves, allowing the torsion spring to wind the pulley and thus to remove the roller housing from the door. It can now be rotated more inwards and can be disconnected from the guide tube.

The mechanism can be reset by cranking back the pulley shaft and resetting the lock pin. For that purpose the pulley shaft is provided with a square end on the inboard side.
To prevent inadvertent operation, the release pin is protected by break access windows, one on either side of the door.

END

53

FUSELAGE

53. FUSELAGE

00. GENERAL

The semi-monocoque fuselage is constructed of frames, formers, bulkheads, a great number of longitudinal stringers and an aluminum alloy stressed skin.

At Sta. 1400 and Sta. 16660 full section pressure bulkheads, separating the pressure cell from the unpressurized fuselage sections, are installed. A partial pressure bulkhead is installed in the upper portion of the forward fuselage at Sta. 5050 in Mk 100 and 200 aircraft or at Sta. 6675 in all other MK's. Aft of this partial pressure bulkhead and towards the wing front spar, the fuselage skin is doubled, the inner skin being the pressure skin. The partial pressure bulkhead in this way forms the beginning of a unpressurized cable duct. All control cables, electrical wiring and piping pass through the partial pressure bulkhead from the pressurized to the unpressurized area through specially sealed apertures, Aft of the wing rear spar the cable duct is formed by the lower portion of the dorsal fin, fitted on the aft section of the fuselage.

In cross-section, the fuselage is circular in shape both above and below floor level, however, the bottom structure has a larger radius. At the intersections two side beams run forward and aft between Sta. 3100 and Sta. 16660. In addition to the side beams, two floor beams serving as crashmembers are installed in the bottom section. At regular distances the frames in the fuselage bottom section are provided with composition type transverse sections for floor supporting purposes. Several apertures for doors and windows are provided in the fuselage pressure cell. Special reinforcements are provided around these apertures. Where necessary, the frames are doubled.

running forward along the edge of the wing intersection.

E. Floor Beams

The raised cockpit floor is supported by the bridge frames in the fuselage lower portion. The cargo compartment floor and the cabin floor are supported by two longitudinal heavy floor beams, the two fuselage side beams and the transverse floor carriers. The floor beams consist of top bottom angle section extrusions, riveted to an aluminum alloy web reinforced with vertical angle section stiffeners. They extend from Sta. 3100 to Sta. 14340. From Sta. 14340 to Sta. 16660 only one floor beam is installed. The box fuselage side beams consist of a vertical web and a corrugated sheet top, interconnected by a special extrusion to which the floor panels are attached.

20.0 AUXILIARY STRUCTURE

A. Floor Construction

Three methods of floor construction are used in this aircraft. The method used depends on the purpose of the floor concerned. Several cargo tie-down and seat attachment fittings are mounted on the floors.

1. Cockpit Floor

The raised cockpit floor consists of several panels of aluminum alloy sheet, reinforced by stiffeners and riveted to the fuselage frames. Tracks for the pilots seats are screwed to the floor structure. The floor panels on either side of the pedestal, are detachable to facilitate inspection and maintenance of the flight controls, cables etc.

2. Cargo Compartment Floors

The floors of the forward and aft cargo compartments are constructed of closely spaced hat section stiffeners bonded to a flat sheet covering. They are composed of several sections and attached to the floor carriers and beams by flathead screws and washers. The various sections can be removed without interfering with the adjacent structure. In the front part of the forward cargo compartment the centre of the floor panels between the floor beams is easily removable for inspection of the electrical equipment underneath the floor. The floor panels are sealed with Scotch tape.

3. Cabin Floors

The cabin floor consists of Mallinson-type floor panels which are made of end grain balsa core sandwiched between aluminum alloy sheets. The panels are attached to the floor carriers and beams by flathead screws and plate nuts. Combiplane floors are of the same construction as those in the cargo compartment.

B. Platforms

Two platforms are installed in the aft fuselage section between Sta. 18160 and Sta. 19180 for use during inspections and maintenance. Each platform consists of a wooden frame, filled with a bonded metal honeycomb layer and sandwiched between aluminum alloy sheets. The platforms are bolted to supports which are riveted to the fuselage frames Sta. 18160, Sta. 18565 and Sta. 19180.

C. Vibration Dampers

Vibration dampers are installed in the aircraft to reduce the noise and vibration level in the forward part of the cabin. These dampers are located on the fuselage frames above the cabin floor.

30.0 PLATES/SKIN

A. Fuselage Skin

The fuselage is covered by 24-ST aluminum clad stressed skin. The skin sheets are bonded and/or riveted to the longitudinal stringers, which are riveted to the fuselage frames.

Doublers internally attached over the fuselage skin joints are sealed with sealant to effect a dry skin joint seal.

B. Ice Protection Plates

Fibreglass plastic ice protection plates are screwed to the outside of the fuselage skin in line with the plane of rotation of the propellers. They protect the fuselage against particles of ice thrown from the propeller blades.

C. Fittings

Two forged aluminum alloy nose landing gear pivot fittings and a fitting for the nose landing gear actuating ram are attached to the forward pressure bulkhead. A bracket for installation of a jack pad is riveted to the bottom of the bulkhead at Sta. 3100.
Heavy aluminum alloy forgings are riveted and bolted to the main frames. These forgings are provided with a forked end, and an integral lug to accomodate the eye fittings and links which are fitted on the front and rear spar of the centre wing. Four eye fittings are bolted between the doubled frames at Sta. 18565 and Sta. 19790 for attachment of the empennage.

D. Fairings

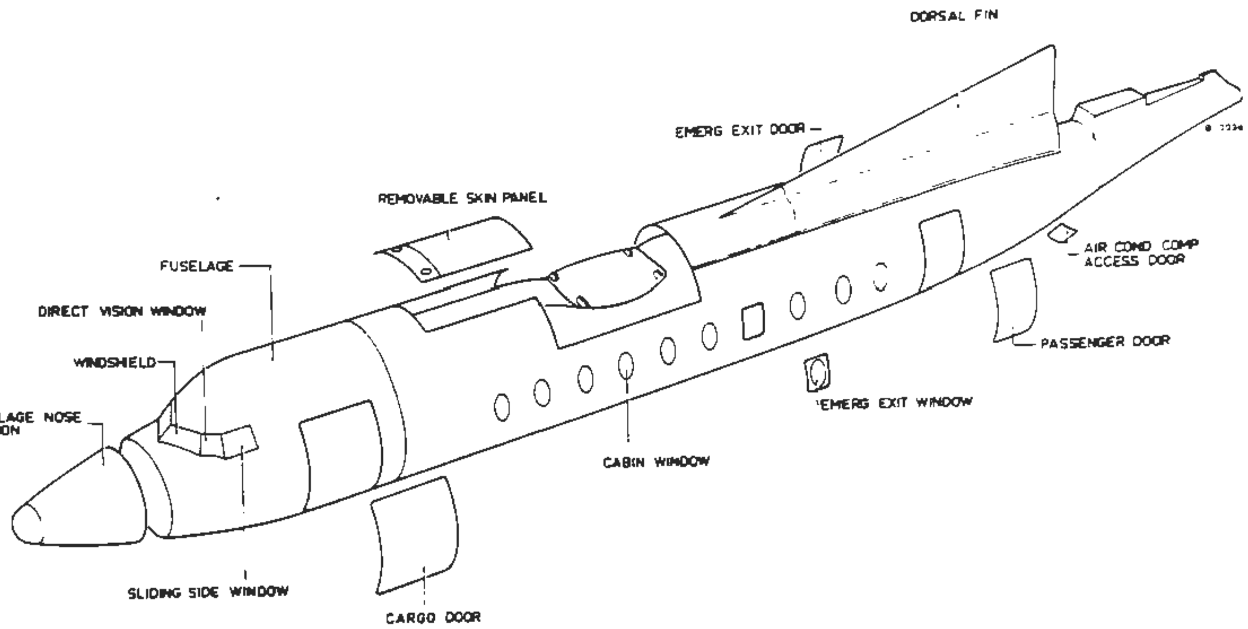
1. Fuselage Nose Section and Radome

The metal nose section is constructed of stretch- formed aluminum alloy plating with frames and longerons. A bulkhead, installed at the front of the metal nose section, provides an attachment for a weather radar scanner unit and the glide slope antenna. It is provided with inspection covers and some airscoops. The radome is constructed of honeycomb sandwiched between fibreglass plastic and attached to the metal nose section by four quick release fasteners. The nose section is attached to bulkhead Sta. 1400 and the nose gear pivot fittings by means of flathead screws.

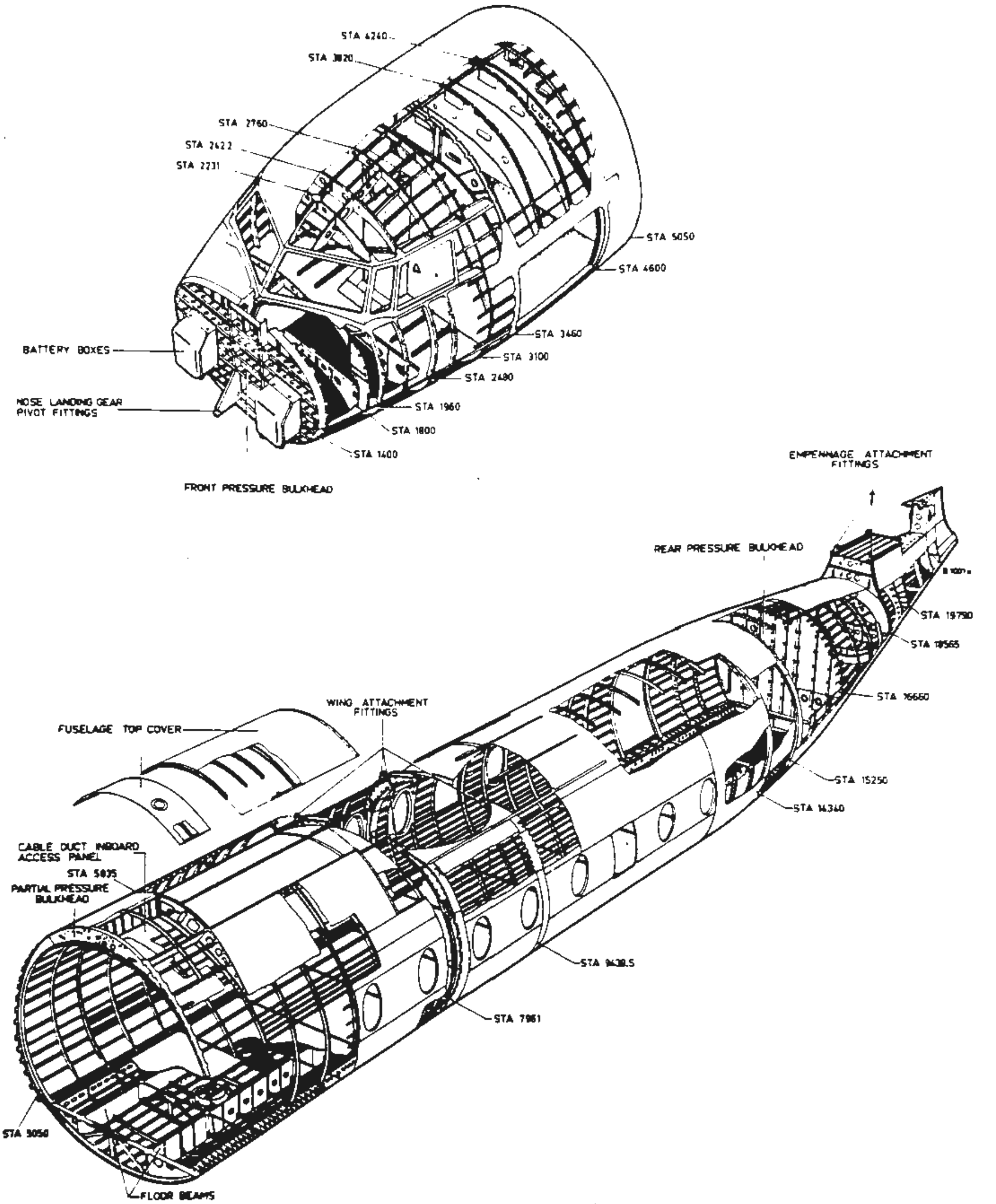
2. Dorsal Fin

The dorsal fin runs from Sta. 10665 aft to the vertical stabilizer. Most of the fin is constructed of a number of frames, formers, longitudinal spars and stringers, covered with an aluminum alloy skin. The removable front section, however, is made of reinforced plastic. Because the dorsal fin lower portion forms a cable duct, it is internally covered with a metal skin and contains brackets and tracks for the attachment of cable pulleys, air ducts, pipes, etc. Two large doors on the left hand rear side provide access to the duct. The dorsal fin frames are bolted to the fuselage structure, while remaining gaps between dorsal fin and fuselage skin are faired by riveted cover strips.

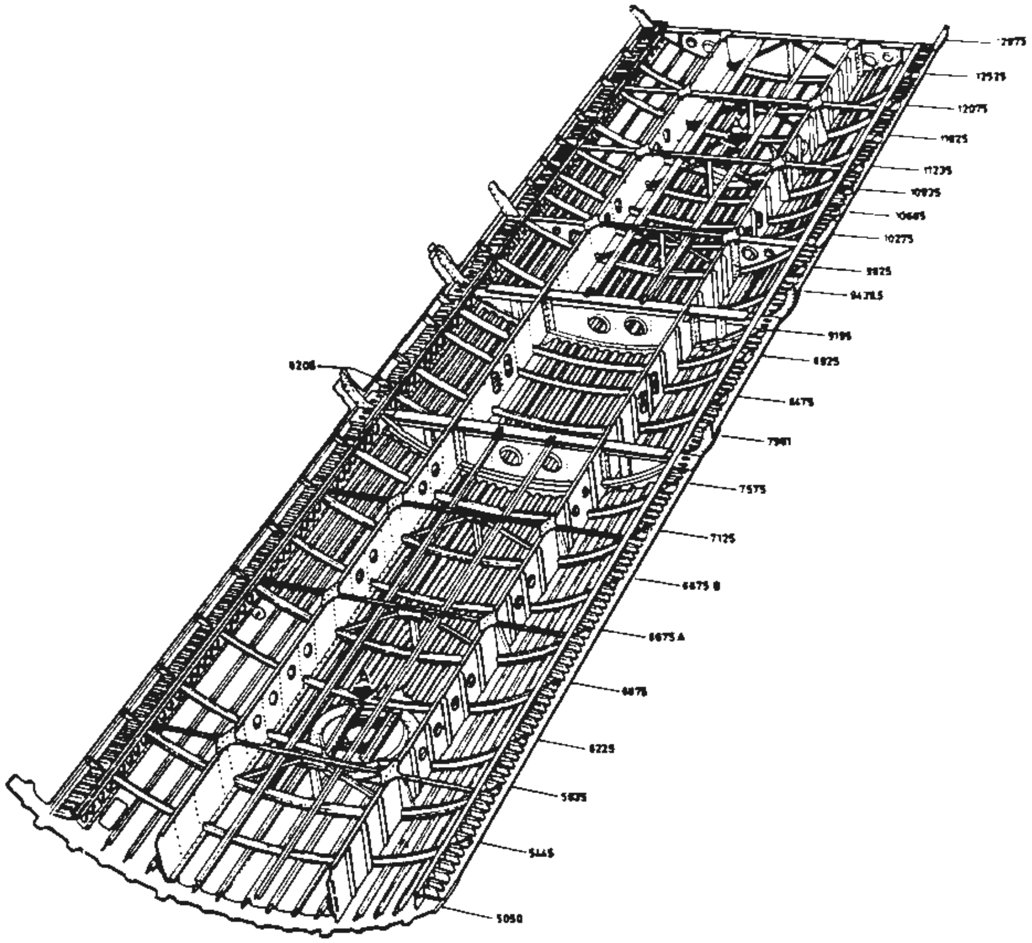
END



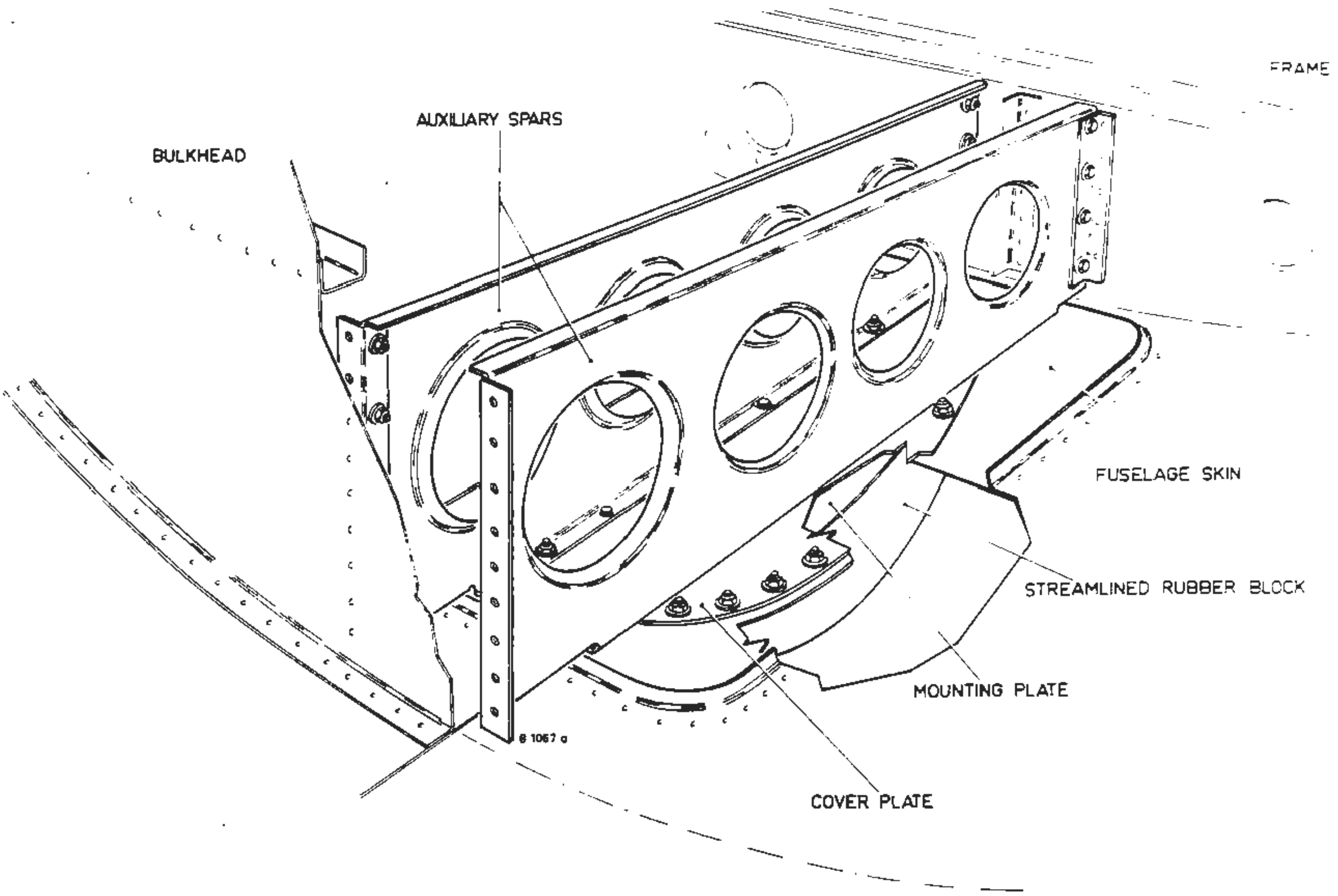
FUSELAGE - STRUCTURAL BREAKDOWN



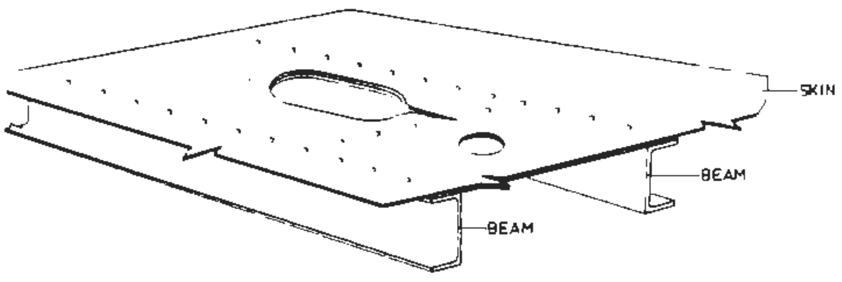
FUSELAGE STRUCTURE



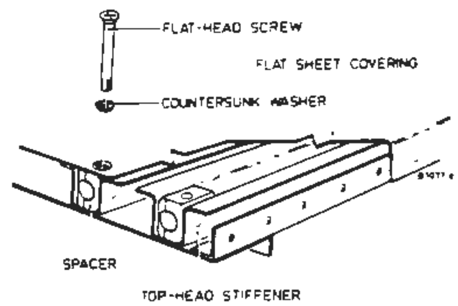
FUSELAGE BOTTOM HALF STRUCTURE



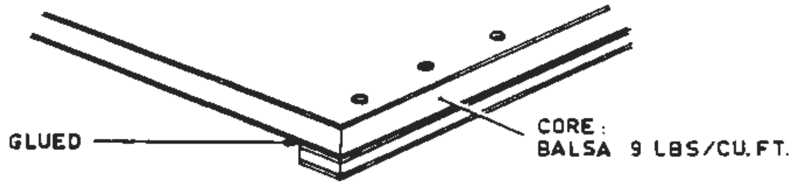
TAIL SKID MOUNTING



COCKPIT FLOORING

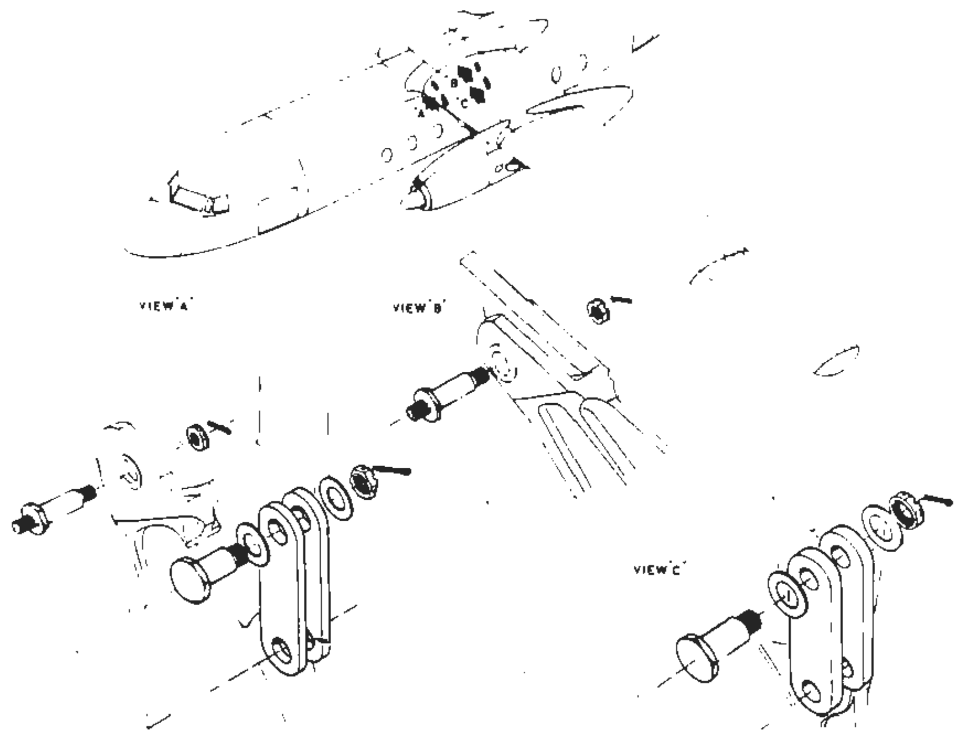


FORWARD- & REAR COMPARTMENT FLOORING

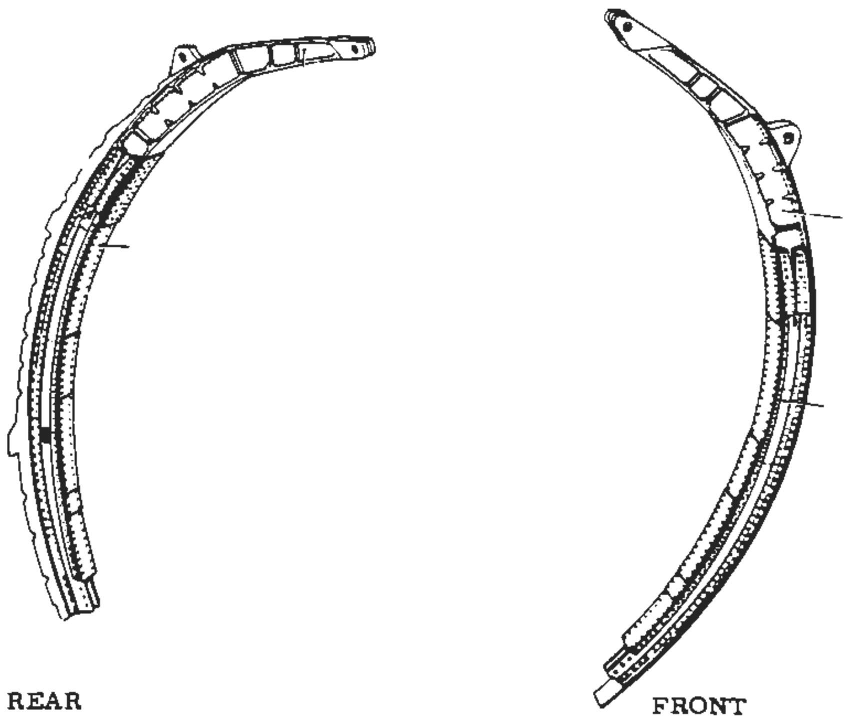


CABIN FLOORING

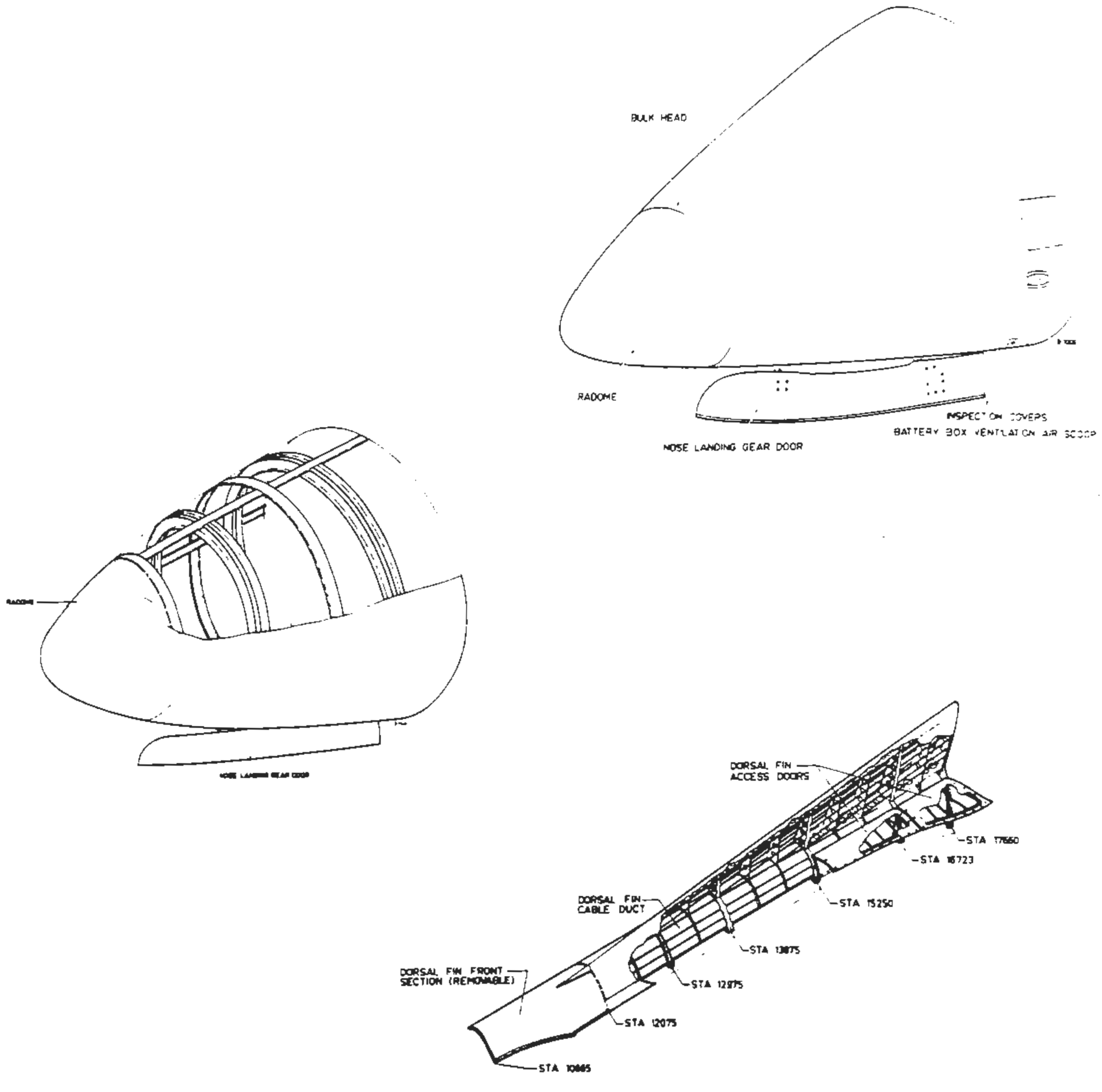
FLOOR SUPPORTING STRUCTURE



WING TO FUSELAGE ATTACHMENT DETAILS



CENTRE WING TO FUSELAGE JOINT DETAILS



FUSELAGE NOSE SECTION AND DORSAL FIN

54. NACELLES

00. GENERAL

The nacelles are permanently attached to the centrewing between Sta 3050 and 4155 and consist of three sections: a removable front section, forming a fairing around the engine and its mounting, a permanently attached centre section and a removable rear section with a plastic tail cone.

The centre section extends from nacelle Sta 1804 to Sta 5720 and is an all-metal construction of transverse bulkheads, frames, longitudinel stringers and stiffeners, covered with riveted skin panels. The outboard skin panels are made of stainless steel to protect the structure against the exhaust gases.

Frames divide the centre section in two compartments to accommodate various systems and system components. The front compartment is divided into an upper compartment which houses the engine gearbox, and a lower compartment. Access to the upper compartment is gained through a large hinged door on top of the nacelle.

Power plant loads are transferred to the wing centre section front spar by four truss supports, a heavy forging and heavy longerons.

The rear section is similar in construction to the centre section. It is attached to the centre section by means of six toggle fasteners.
Access doors are provided for inspection of the various components in the different nacelle compartments.

10.0 MAIN FRAME

The nacelle frames are sheet metal parts and can be divided into web-type and supporting rib-type frames.
The stainless steel fire wall is a web-type frame and supports the power plant, it is provided with several sealed passages for pipes, electrical wiring power plant controls and the jet pipe.
The other frames are of an aluminium alloy construction, the rear most frame is provided with adjustable fork-ends for the attachment of the rear section.

Stringers form the supporting frame work for the skin panels, top hot section longerons form the lower longitudinal support for the frames and skin panels.

Four welded, tubular steel truss supports are installed in the centre section to retain the fire wall and to support the power plant. TWo of these supports are suspended between the centre wing front spar and the fire wall in the accessory gearbox compartment and the other two are installed below the exhaust shroud between the fire wall and a heavy forging on frame 2574.

This forging also forms a hinge point for the main landing gear drag strut and at the upper end, for the main landing gear pneumatic ram.

A fixed cowling assembly is suspended on the front of the fire wall and is contoured to fit the nacelle and the cut-out in the aft end of the power plant bottom cowling panel. The assembly is supported at the base of the fire wall by brackets. A support arm, to which is attached the support strut of the bottom cowling panel, is riveted to the right-hand bracket.

20.0 ATTACH FITTINGS

The nacelle centre section is bolted to the front spar of the wing centre section by three fittings and to the rear spar by two fittings. The centre fitting is an aluminium forging and extends vertically down to form a support at its lower end for the landing gear drag strut and pneumatic ram.

The two rear fittings connect the centre wing rear spar to the front of frame Sta. 4052.

A steel flap track is installed on each side of the nacelle, they are bolted to brackets on the lower skin of the centre wing section and to a supporting structure between the front spar and frame Sta. 4950.

Four welded steel or forged engine mount and truss support brackets are riveted to the fire wall. These brackets have line-reamed holes drilled through the mounting bosses to receive the engine mount and truss support retaining bolts.

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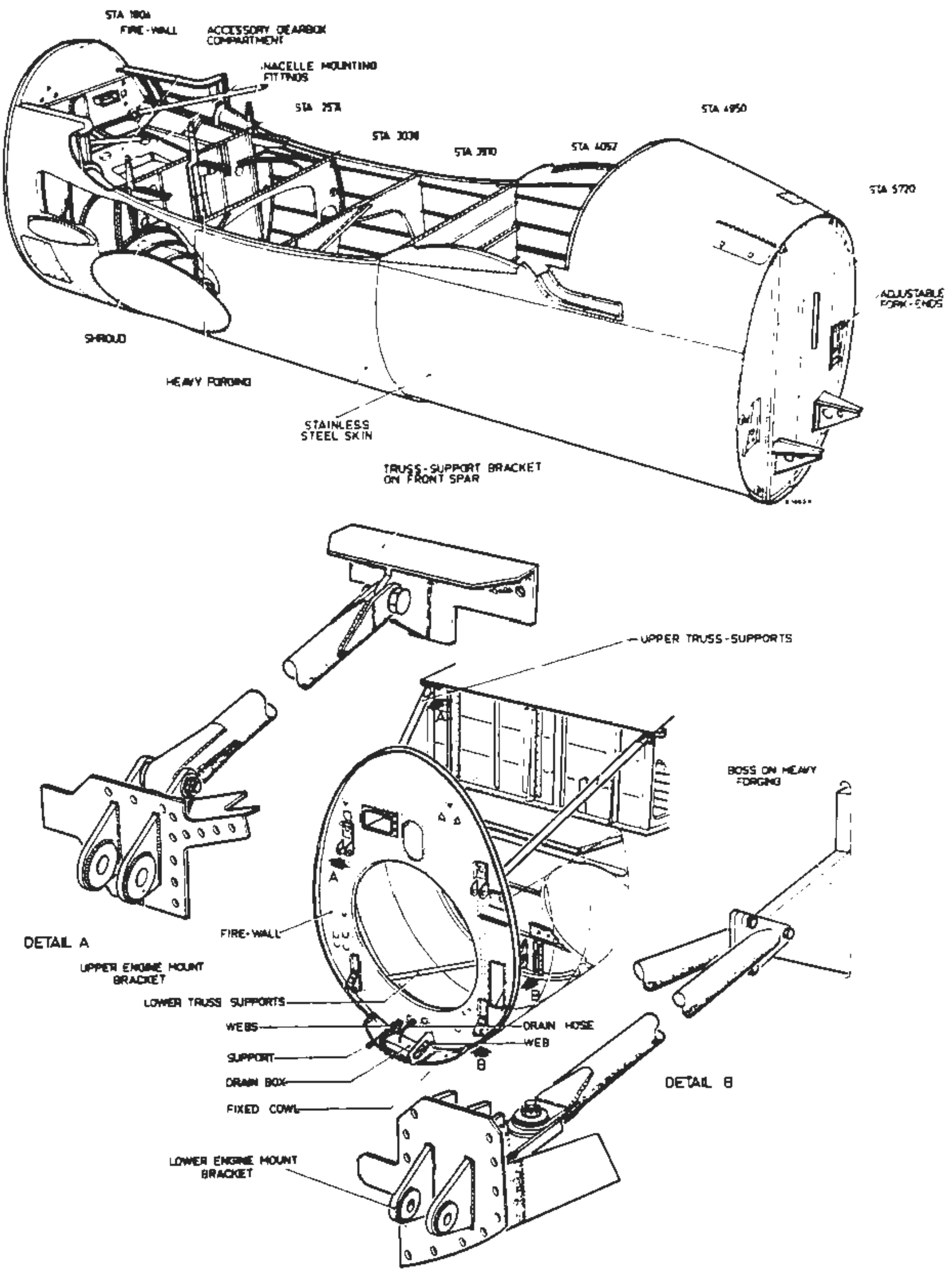
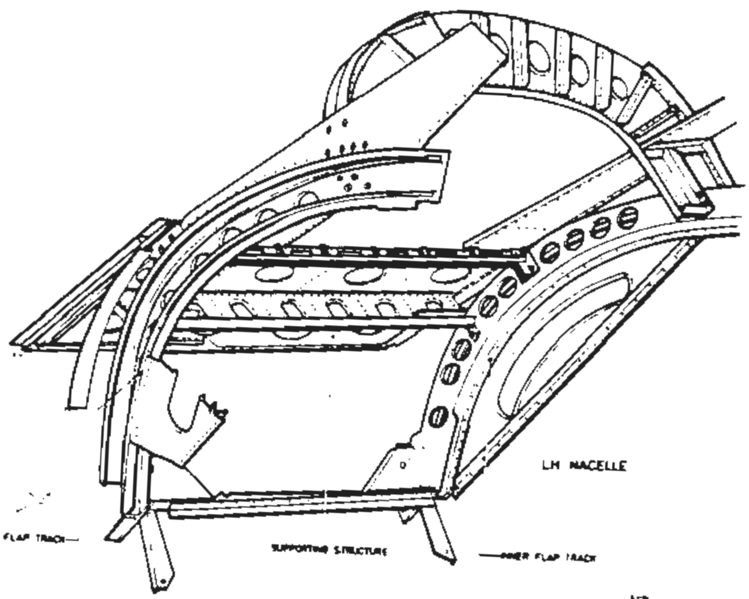
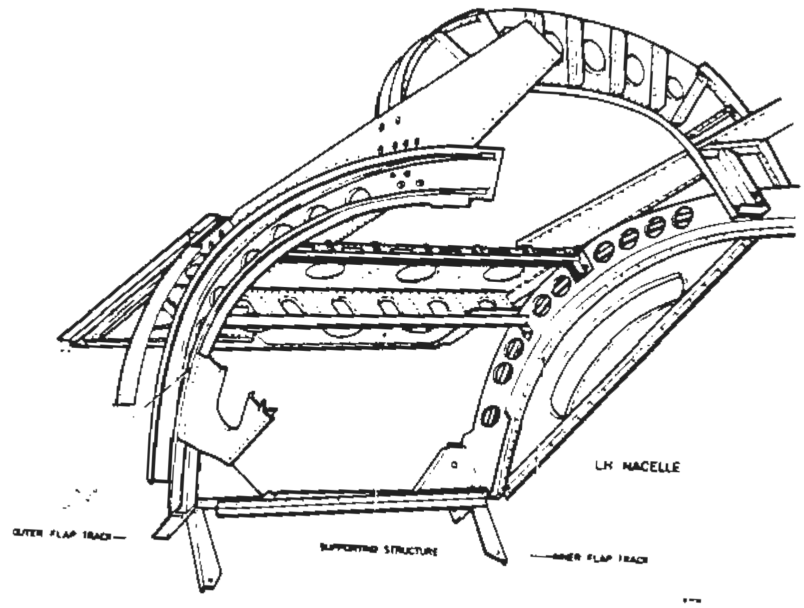


NACELLE STRUCTURE



NACELLE STRUCTURE DETAILS



NACELLE STRUCTURE DETAILS

STABILIZERS

55

55. STABILIZERS

00.0 GENERAL

The empennage consists of a vertical and a horizontal stabilizer, both of which are full cantilever stressed members of an all-metal construction.

10.0 HORIZONTAL STABILIZER

The horizontal stabilizer is an all-metal construction except for the leading edges which are made of fibreglass-reinforced plastic.

It consists of left-hand and right-hand units which are riveted and bolted together at the fuselage centre line.

The structure consists of a front and rear spar of conventional construction interconnected by web-type main ribs.
The structure is covered with four skin panels at the top and four at the bottom and stringers of top-hat sections bonded to skin panels and riveted to the rib formers.

The stabilizer is attached to fittings on the fuselage by means of fittings on front and rear spars: These fittings are braced by front and rear truss assemblies.

The leading edge consists of removable inboard and outboard sections constructed of honeycomb fitted in a spruce frame and bonded between fibreglass plastic sheets. Aluminium alloy chair sections are bonded to the upper and lower edges of the spruce frame to provide for attachment to the front spar.

Stabilizer tips are secured to the end rib with screws.
TWo weights are attached to each end rib to reduce vibration in stabilizer and rear fuselage.
The stabilizer is contoured to the fuselage by eight removable and two fixed fillets of metal and fibreglass-reinforced plastic.

20.0 ELEVATOR

The left-hand and right-hand elevators are identical except that the left-hand elevator has a trim tab attached to the inboard trailing edge.
Each elevator consists of a front, middle and rear spar interconnected by ribs and covered by aluminium alloy skin panels.

A fibreglass-reinforced plastic leading edge is bolted to the front spar by foam blocks and screws, each attachment hole is filled with plastic wood and covered with a fabric patch.

Weights, comprised of one large and a number of small ones are bolted to the front spar for balancing the elevator.

TWo hinge fittings are mounted on the middle spar for attachment to the stabilizer. The elevator is also attached to the rear truss assembly of its inboard end by a bearing block fitted to a torgue tube attached to the inboard rib on the hinge line.

A control lever is bolted to the end of the torgue tube.
On the left-hand elevator are three hinge brackets for the attachment of the trim tab.

The trim tab is also an all-metal construction consisting of two spars ribs and covered with a one-piece skin. Fork ends secured to the front spar act as tab hinges.

30.0 VERTICAL STABILIZER

The vertical stabilizer is an all-metal structure except for the leading edge which is of fibreglass-reinforced plastic.
The structure consists of an auxiliary spar, which is basically a reinforcement for the leading edge, a front spar and rear spar of truss type construction interconnected by ribs of conventional web design.
The structure is covered with ten butt-joined skin panels reinforced with top hat stringers which are bonded to the skin and riveted to the ribs.

Access panels are provided in the trailing edge and the left-hand skin panels for maintenance and inspection.

The leading edge is similar in construction to the horizontal stabilizer leading edge.

The stabilizer tip is removable and includes a mounting flange for the anti-collision light.

The vertical stabilizer is contoured to the dorsal fin by removable aluminium alloy fillets.

40.0 RUDDER

The rudder consists of a front, middle and rear spar interconnected by pressed sheet ribs and covered by aluminium alloy skin.
A fibreglass-reinforced plastic leading edge is bolted to the front spar.
Weights, comprised of one large weight and a number of small ones are bolted to the front spar for balancing of the rudder.

A cast magnesium alloy torque tube with integral control lever is bolted to a mounting base of magnesium alloy at the lower rib.
The mounting base incorporates the lower hinge bracket, two additional hinge fittings are riveted and bolted to the middle spar and ribs for attachment to the vertical stabilizer.

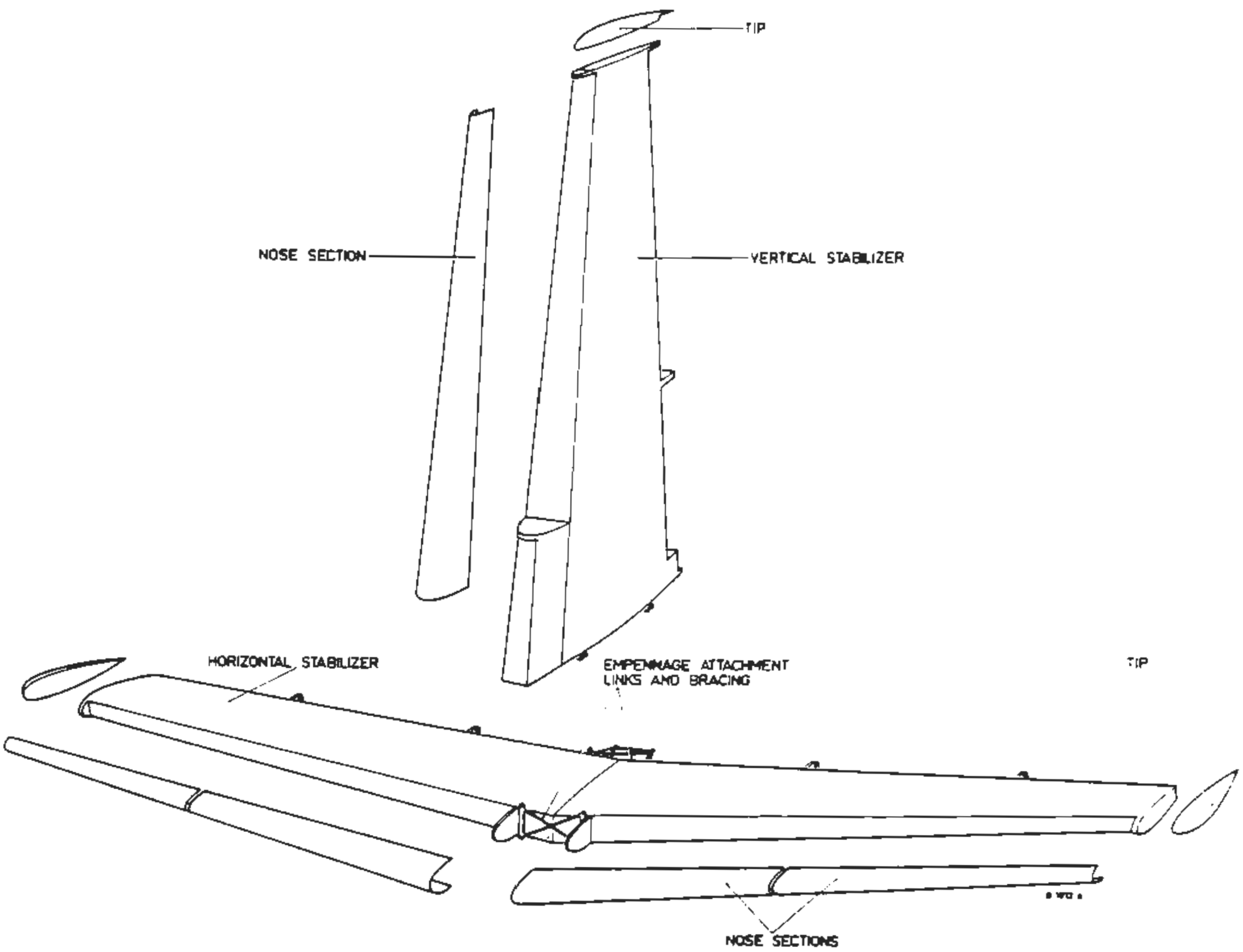
Control rods for the operation of the balance tab and trim tab pass through slots in the rear left-hand skin panel.
The trim tab and balance tab are of an all-metal construction of two spars, ribs and covered by a one-piece skin riveted to the spars and ribs.

50.0 FITTINGS

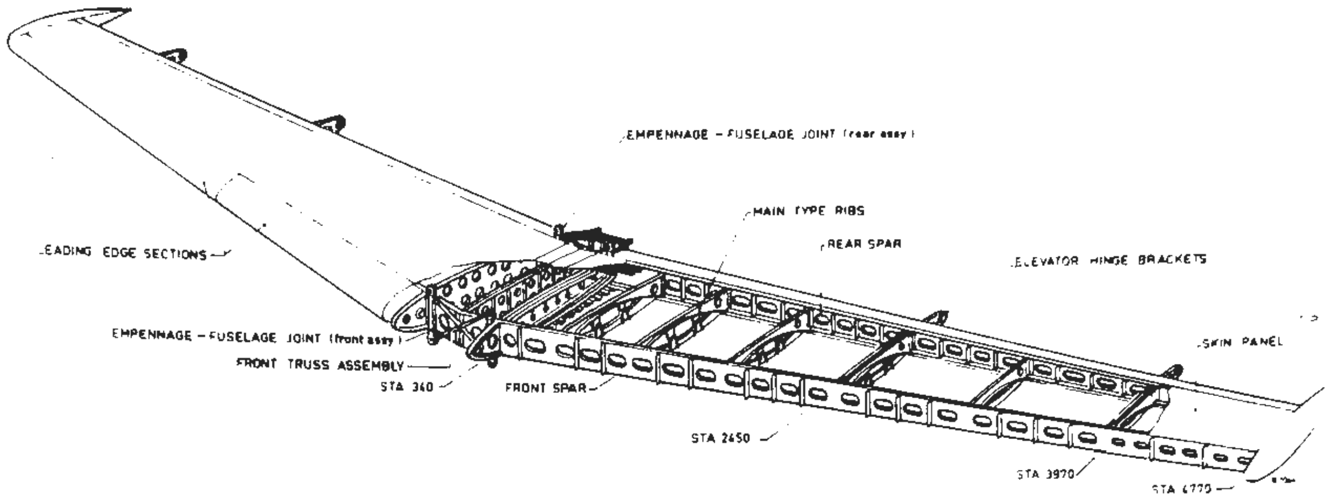
An aluminium alloy fitting is riveted to the left- and right-hand spar caps of front and rear spars for attachment of the vertical stabilizer to the horizontal stabilizer. Hinge arms for attachment of the rudder are fitted to reinforced ribs.

The horizontal stabilizer is attached to the fuselage by machined aluminium alloy forged fittings bolted between extruded angles which in turn are bolted to the front and rear spars.
The fittings are also used for attachment of the vertical stabilizer.
Hinge fittings for attachment of the elevators are bolted and riveted to ribs in the horizontal stabilizers and are provided with ball bearings.

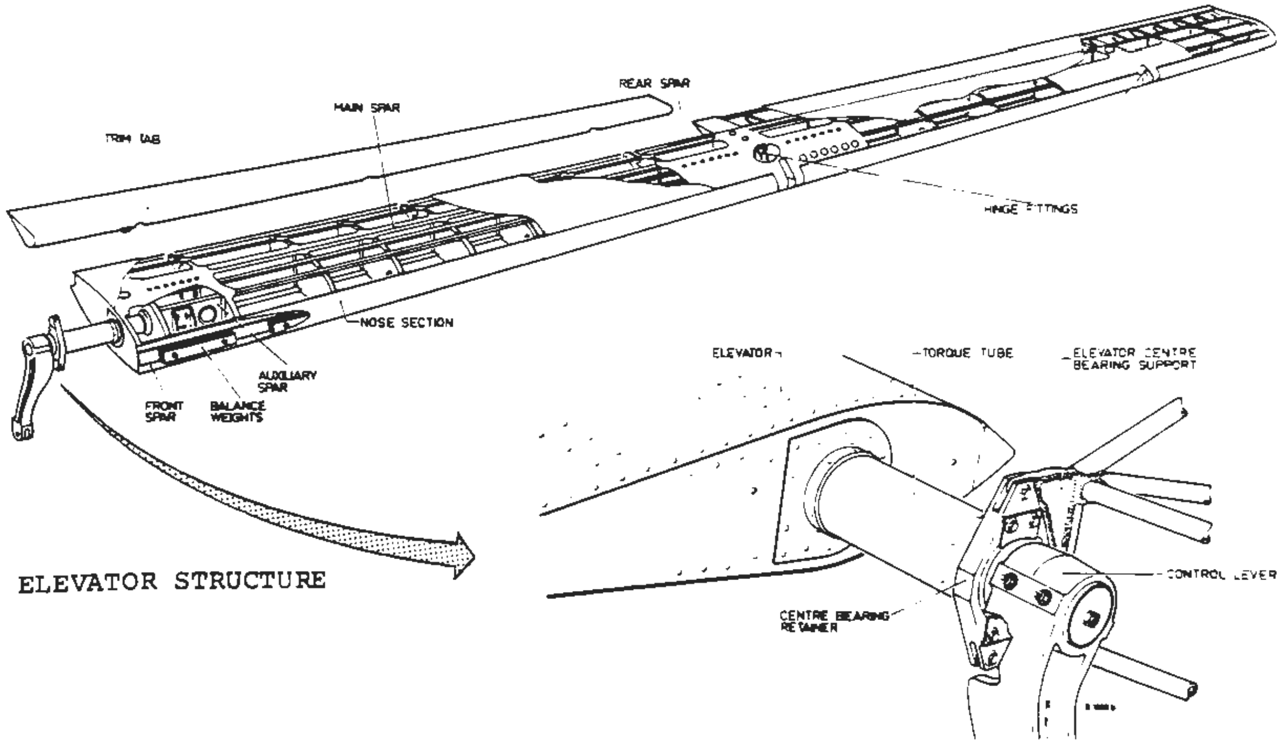
END



EMPENNAGE - STRUCTURAL BREAKDOWN

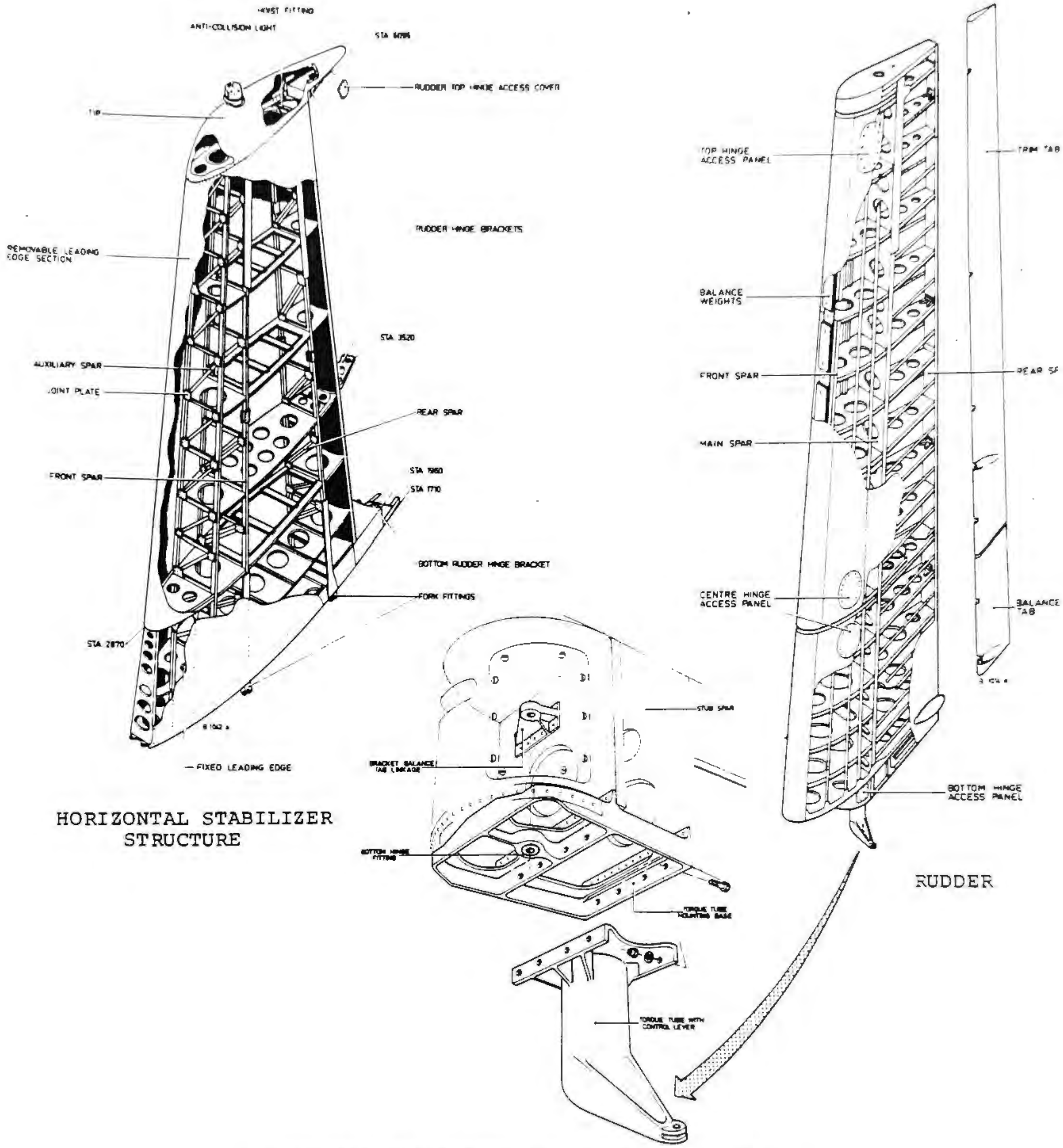


HORIZONTAL STABILIZER STRUCTURE



ELEVATOR STRUCTURE

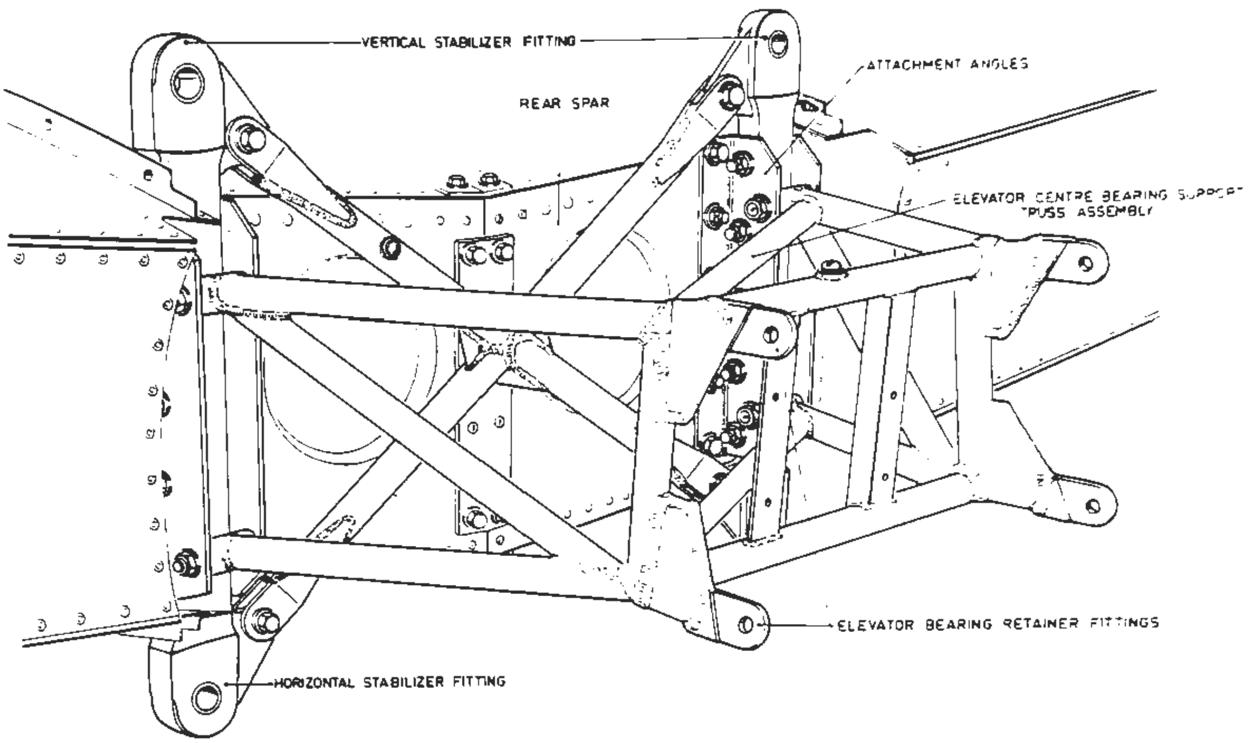
HORIZONTAL STABILIZER AND ELEVATOR STRUCTURE



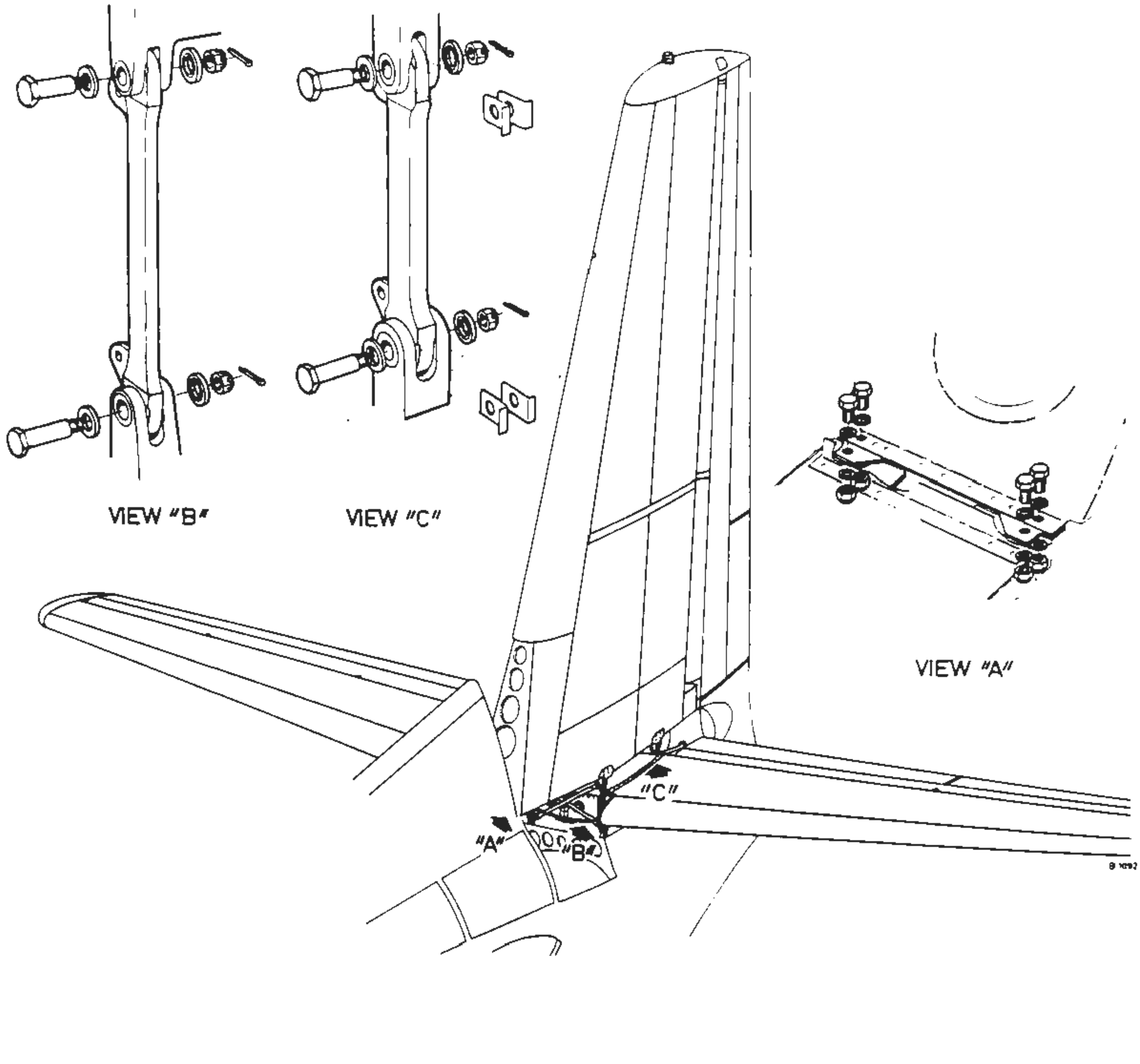
HORIZONTAL STABILIZER STRUCTURE

RUDDER

VERTICAL STABILIZER AND RUDDER STRUCTURE



ELEVATOR BEARING SUPPORT ASSEMBLY



HORIZONTAL - AND VERTICAL STABILIZER ATTACHMENT POINT DETAILS

56. WINDOWS

00. GENERAL

The aircraft windows are divided into two main classes according to construction and location, the cockpit windows and the cabin windows.

The cockpit windows consist of two electrically-heated windshield panels, two direct vision windows and two sliding side windows.

The windshields are secured to the fuselage structure with bolts, the direct vision windows are hinged at the forward side and open inwards.

The sliding side windows are mounted in longitudinal tracks so that the windows can be rolled fore and aft. The RH sliding window may also be used as an emergency exit.

The cabin windows consist of two elliptical panes, an inner and an outer pane. The outer pane is attached to the fuselage skin by means of bolts together with a profiled window pane to which the inner pane is bolted.

10.0 COCKPIT WINDOWS

A. Windshields

Each windshield consists of a vinyl plastic sheet sandwiched between an inner and outer glass pane.

A NESA-coating is on the inner side of the outer glass pane and provides for electrical heating of the windshield.

The edges of the vinyl core extend beyond the edges of the glass panes and are reinforced with a one-piece aluminum alloy insert to distribute the loads evenly on the windshield panel.
The panels are secured to the cockpit frame with countersunk screws and aluminum retainers, one on each side of the vinyl core.

Grommets are fitted in the attachment holes to prevent excessive squeezing of the vinyl core. A rubber seal is fitted between the frame and outer retainer, a sealing compound is used to fill up the seam between frames and windows on the exterior to overcome any uneveness.

To relief the high shear stresses which can occur at the edges of the panel at very low temperatures, a parting medium is introduced around the edges of the panel between the glass and vinyl laminations.
This also allows a slight movement between the glass and vinyl plies at a point where the panel is subjected to a certain amount of flexing under pressurisation loads.

B. Direct Vision Windows

The direct vision window consits of a cast magnesium alloy frame with a three-ply panel of glass-vinyl-glass.
The vinyl core extends beyond the edges of the glass pane and is shaped to the panel to be glued and bolted to the frame.

For demisting purposes a thin transparent plastic pane is fitted to the inner surface of the window. The space between the demisting pane and the inner glass pane is connected to the air conditioning system. Air outlet holes are provided at the top of the demisting pane to allow ventilation.

The windows are hinged at the forward side and open inward, a leaf spring, installed above the windshield, will hold the window in the fully open position.
A locking lever on the rear side of the window operates the locking pins.

C. Sliding Windows

Each sliding window consists of a cast magnesium alloy frame with a three-ply panel of glass-vinyl-glass.
The edges of the vinyl core extend beyond the edges of the glass pane and are reinforced with a one-piece metal insert. The panel is secured to the frame with countersunk screws and grommets fitted in the attachment holes.
A plastic panel is bonded to the inner glass pane to form an air-sealed space for demisting purposes.

The sliding side windows are attached to a magnesium frame which is held in position on the upper and lower edges by longitudinal guide tracks.

The tracks are hinged to the fuselage structure and can be moved inboard and outboard by means of a handle located at the cockpit side wall.

When the lever is placed in the unlocked position, the tracks move inward, bringing the window frame inboard and freeing it to be moved backwards manually by another handle, connected to the window frame. In order to close the window, it must be brought to its most forward position by hand. Then, when the control lever is pushed in the locked position, tracks and frame move outboard, pressing the frame against its seal on the fuselage structure.

20.0 CABIN WINDOWS

The cabin window design, like that of the cockpit windows, is an example of fail-safe back-up structure.

The window consists of two separate elliptical panes of plexidur, and an inner and outer pane. The total pressure load is carried by the outer pane. If the strength of the outer pane is lost due to damage, the inner pane, normally unloaded, takes the pressure load.

The outer window pane is attached to the fuselage skin by means of a large number of 3/16-inch bolts together with a profiled window pane to which the inner pane is bolted. Between the outer pane and fuselage skin a rubber sealing is fitted.

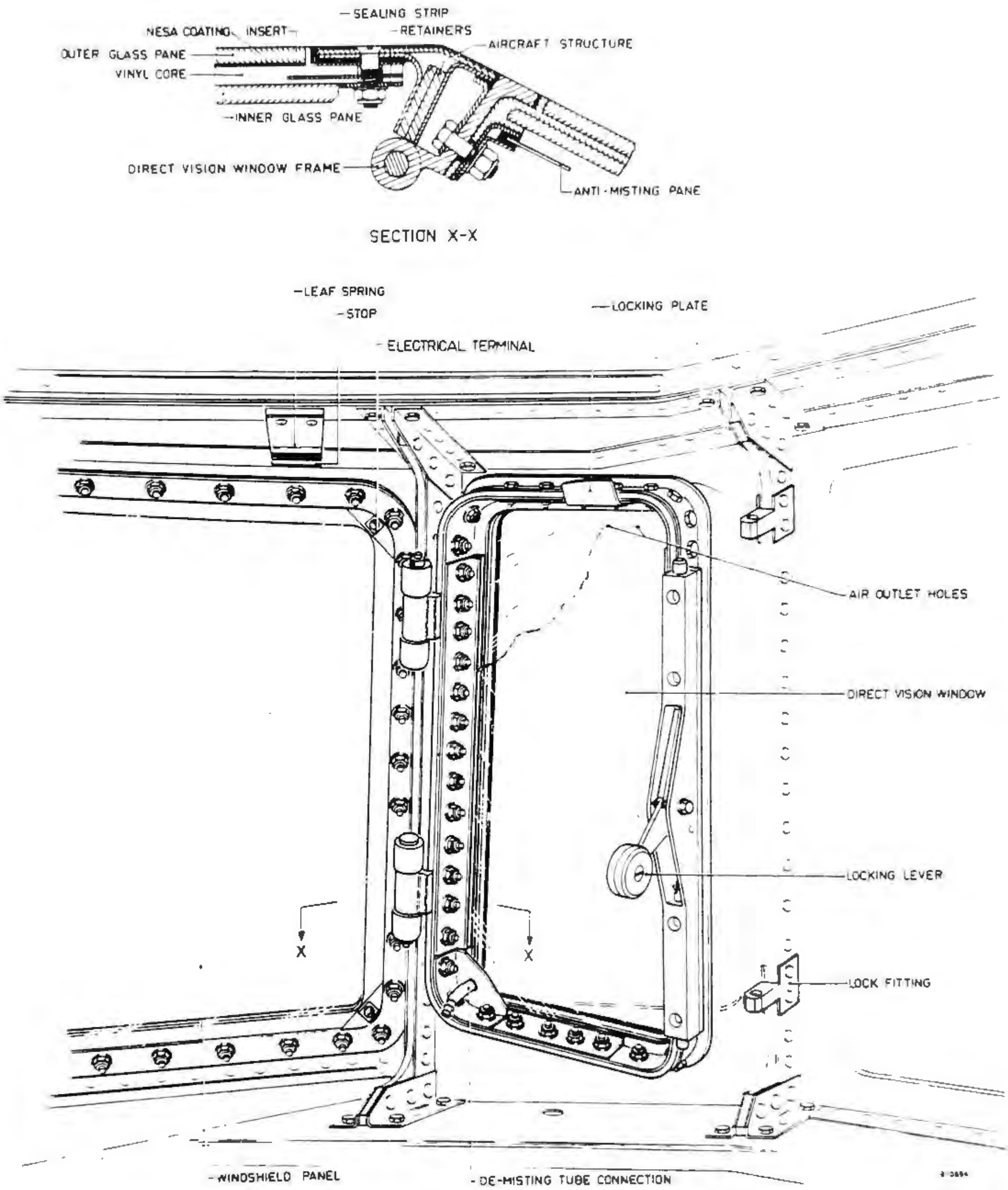
The inner and outer pane are respectively 0.12 and 0.20-inch thick. The edges of the outer pane are reinforced with several layers of glass cloth impregnated with resin. The inner pane is not edge-reinforced because normally it is not loaded.

All windows, including the emergency exit windows, are demisted by circulating warm air between the window panes. This air is tapped off from the air conditioning duct in the hat racks, and supplied via plastic tubing to the top of the window frames. A hole at the bottom of the window frame serves as an exhaust.

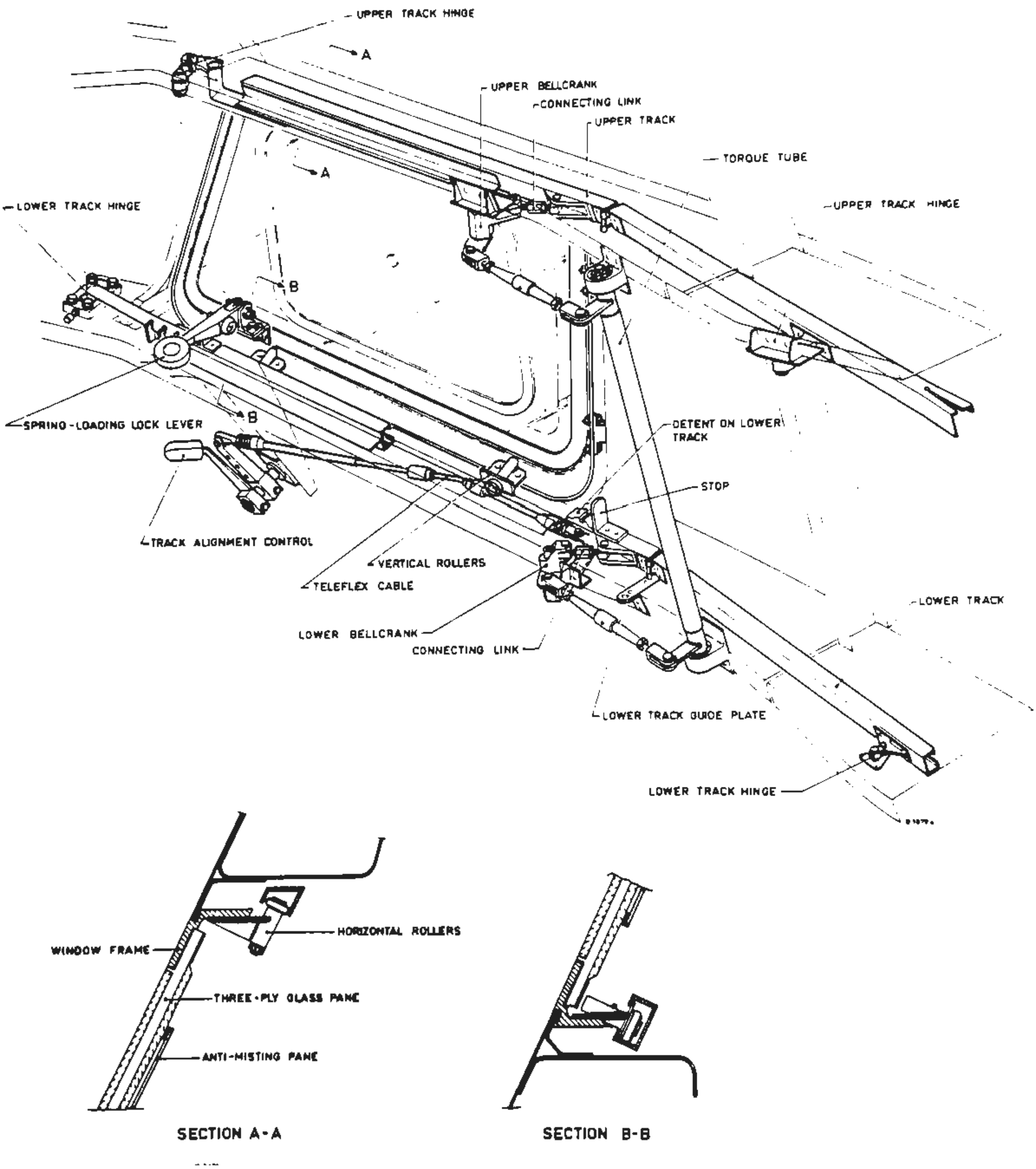
The emergency windows have their air supply connected at the bottom of the window frame, via an automatic disconnect coupling.

When a tenth window is fitted in the plane of propeller rotation, the outer pane is protected on the outside by an additional "Plexidur" pane with an airspace in-between vented to atmosphere.

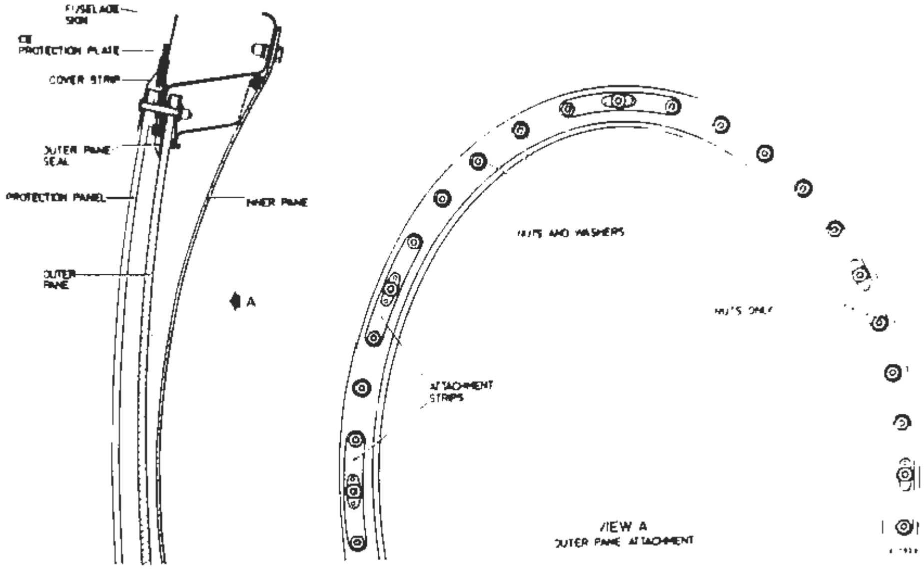
END



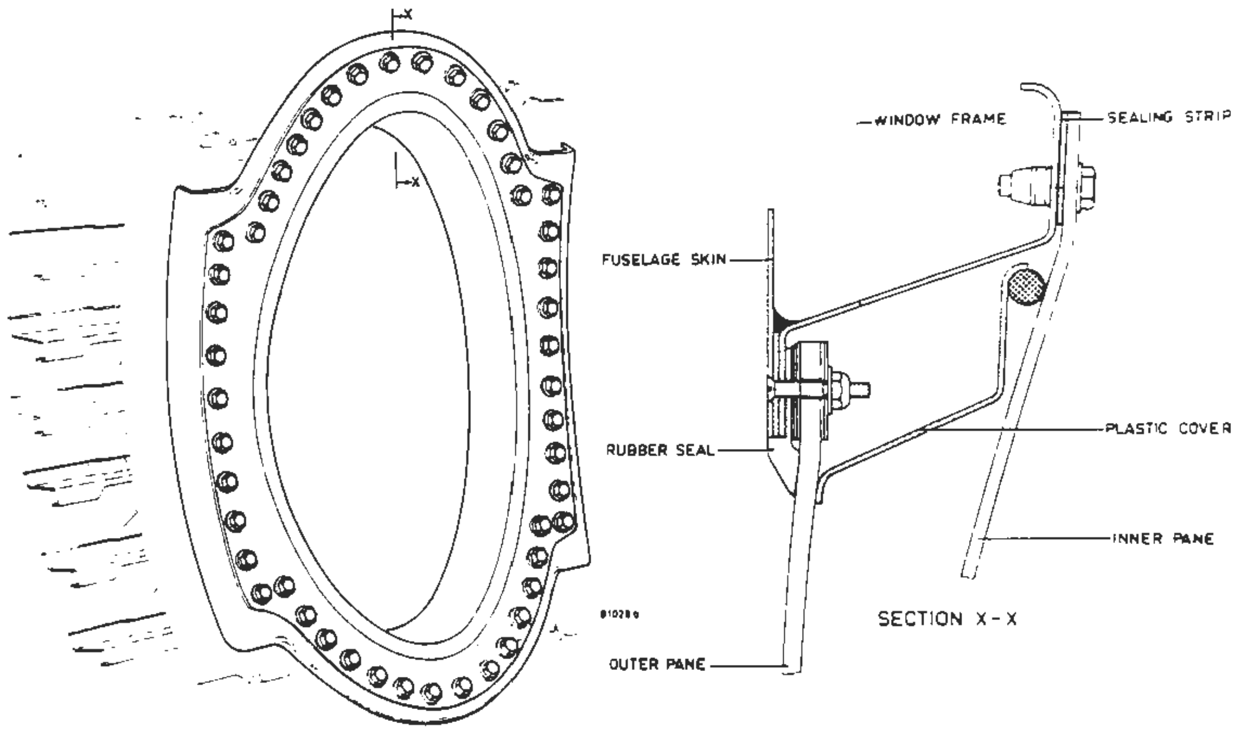
WINDSHIELD AND DIRECT VISION WINDOW



SLIDING SIDE WINDOW AND WINDOW TRACK ALIGNMENT MECHANISM



CABIN WINDOW IN PLANE OF PROPELLER ROTATION



CABIN WINDOWS

57. WINGS

00. GENERAL

The wing is an all-metal, full-cantilever, two spar assembly consisting of a centre wing section with two permanently installed nacelles to which the right-hand and left-hand outer wing sections are attached. The centre wing is semi-permanently connected to the fuselage. TWo inner flap sections are installed on the centre wing and an outer flap section on each outer wing.
Wing stations are numbered from 0 at the fuselage centre line, to 14300 at the end ribs where the wing tips are installed.

10.0 WING PANELS

A. Centre Wing

The centre wing section extends between wing stations 4155 and consists of a torsion cell, a detachable leading edge and a trailing edge.
The torsion cell consists of a front and rear spar, web and truss-type ribs and top and bottom skin.
The spars are of the fully web-type with caps of staggered laminated angles bonded together.
The ribs are symmetrical about the fuselage centre line and are divided into nose, interspar and trailing edge ribs.
The nose ribs provide mounting points for the leading edges.
Interspar ribs are of the full web-, partial web- and truss-type.
All metal trailing edge ribs are located at Sta. 1040 and incorporate the inboard inner flap rail, the remaining trailing edge ribs are of metal/plastic or of plastic construction.
The interspar structure is covered by three aluminium skin panels at the top and three at the bottom, they are butt joint at sta. 1040
The joints are reinforced by heavy riveted doubler plates.
Spanwise stiffness is provided by riveted and bonded stringers.
Access panels in the bottom skin allow for inspection and maintenance.
The trailing edge skin is of laminated plastic sheets, the under surface of the trailing edge has access openings which are covered by hinged metal covers.

B. Outer Wing

The outer wing structure is identical to the structure of the centre-wing and extends from Sta. 4245 to Sta. 14300 where the wingtip is installed.
Front and rear spars form a box construction with the upper and lower skin panels. Ribs are built between the spars.
The space in the torsion cell between the fuel-tight end ribs at Stations 4245 and 10030 forms an integral fuel tank.
The tank space is sealed with sealing compound and is coated with anti corrosion compound. Tank baffles are installed on certain ribs, to prevent surging of fuel.
A reinforced rib is built at station 10030 where the outboard flap-rail is installed. Aileron hinge brackets are bolted to the rear spar.
A heavy bracket which hinges the flap outer section is riveted to the rear spar.

The wing spars are of conventional built-up stiffened web and cap construction. The webs are made of 7075 aluminium alloy and reinforced by angle section stiffeners and bonded doublers. The upper and lower spar caps are made up of bonded laminations formed into angle and

T-sections. Both front and rear spar caps, are made of 2024 aluminium alloy.
The front spar consist of one built-up continuous assembly from tip to tip with detachable splices at the Stations 4155 at each side of the centre wing section. The front spar also supports the wing leading edge structure.
The rear spar is similar in construction to the front spar, but due to the taper of the wing the main rear spar terminates at Sta. 10030. The remaining part, up to Sta. 14300 is shifted forward to form an auxiliary spar for aileron attachment.

Three types of interspar ribs are used; the fuel-tight type, the baffled type and the majority of them truss-type.
TWo web type, fuel-tight, ribs in each outer wing at Sta. 4245 and 10030, comprise the chordwise walls of the integral fuel tanks. A series of fork fittings pass through the top of the fuel-tight end rib at Sta. 4245 which forms a part of the outer centre wing joint.
Truss-type ribs are used to provide a chordwise supporting structure of the wing skin between the spars. Truss-type ribs are of a built-up structure consisting of upper and lower shaped caps supported by the same type stiffeners.
Baffled ribs are located at wing stations 8847, 7900 and 5350.
The baffled rib located at Sta. 6550 is of special design.
These ribs have holes to permit fuel passage but retard fuel surging between the bays.
The baffled ribs are basically the same as the truss-type ribs but with an additional riveted-on web plate. The web plate is provided with beaded lightening holes.
The baffled rib at Sta. 6650 is of a full rib design, with lightening holes, but without the supporting structure of a truss-type rib.

20.0 AUXILIARY STRUCTURE

The leading edges on centre wing and outer wing are secured to the front spars and the nose ribs and are symmetrical about the fuselage centre line. They consist of removable sections and are identical in construction to the leading edges of the horizontal stabilizer. A rubber de-icing boot is permanently bonded to the leading edge section.
The sections between Sta. 2805 and Sta. 3050 are of all-metal construction and contain an air intake to provide cooling air to the generator, alternator ducts and the jet pipe shroud ducts.
The removable metal wing outer panel tips are provided with a removable cap which incorporates a plastic window for a navigation light mounted on the front rib, and a hole through which the pitot head probe protrudes.
The wing centre section is contoured to the fuselage by twelve removable fibreglass-reinforced plastic fillets.
Other removable plastic fairings are installed over flap support fitting, flap drive mechanism and push-pull rods which operate the aileron, spring tab and balance tab.

40.0 FITTINGS

Fittings on the centre wing section consist of main landing gear fittings, centre wing to fuselage fitting, engine mount supports, inboard inner flap tracks, jack point and stringer joint fittings.
The outer wing fittings consist of nine stringer joint fittings, hoist fittings, aileron hinge brackets and an aileron inboard hinge fitting.
The centre wing to fuselage joint consists of eight light alloy fittings on the centre wing spars, four on the front spar and four on the rear spar.

The four inboard fittings connect directly with four lugs on the fuselage frames at Sta. 7961 and 9439 by means of special, high-tensile steel bolts and castle nuts locked with split-pins.
The four outboard fittings connect with the four outboard lugs on the fuselage frames by means of steel link plates which interconnect the lugs. These are fastened by special high-tensile steel bolts, dural washers, castle nuts and split-pins.
Three fuselage stringers are joined to three centre wing stringers which protrude from the centre wing spars.
The wing opening in the fuselage pressure cell is closed by the centre wing bottom skin being riveted to the fuselage skin.
The outer wing to centre wing connections at Sta. 4155 are made by fork fittings at the upper side of the joint whilst doubler plates are used at the upper and lower skin joints and at the front and rear spar joints.
The male halves of the fork fittings are bolted to the tophat stringers on the upper skin panels of the centre wing, the female halves are attached in the same way to the outer wing. All connections are made by bolting.

50.0 FLIGHT SURFACES

Ailerons and flaps are conventional type all-metal control surfaces which, except for the flaps, are statically and dynamically balanced.

A. Ailerons

The aileron structure is formed by a front, centre and rear spar, spaced by transverse ribs and covered with skin panels, which are riveted to the spars and ribs. Bonded strips and stringers reinforce the skin panels.
Counterbalance weights are bolted to the forward side of the front spar and are covered with the plastic nose section of the aileron, which is also bolted to the front spar.
Three brackets on the outer wing panel hinge the aileron to the wing and fit into slots in the aileron nose section at stations 3849, 2497 and 1249.

A forged light-alloy aileron inboard hinge and stop assembly, fitted with a ball bearing, is installed at the end rib at station zero.
Three hinge brackets for the springtab and four for the balance tab are riveted to the ribs and protrude through the rear spar. All brackets are fitted with ball bearings.

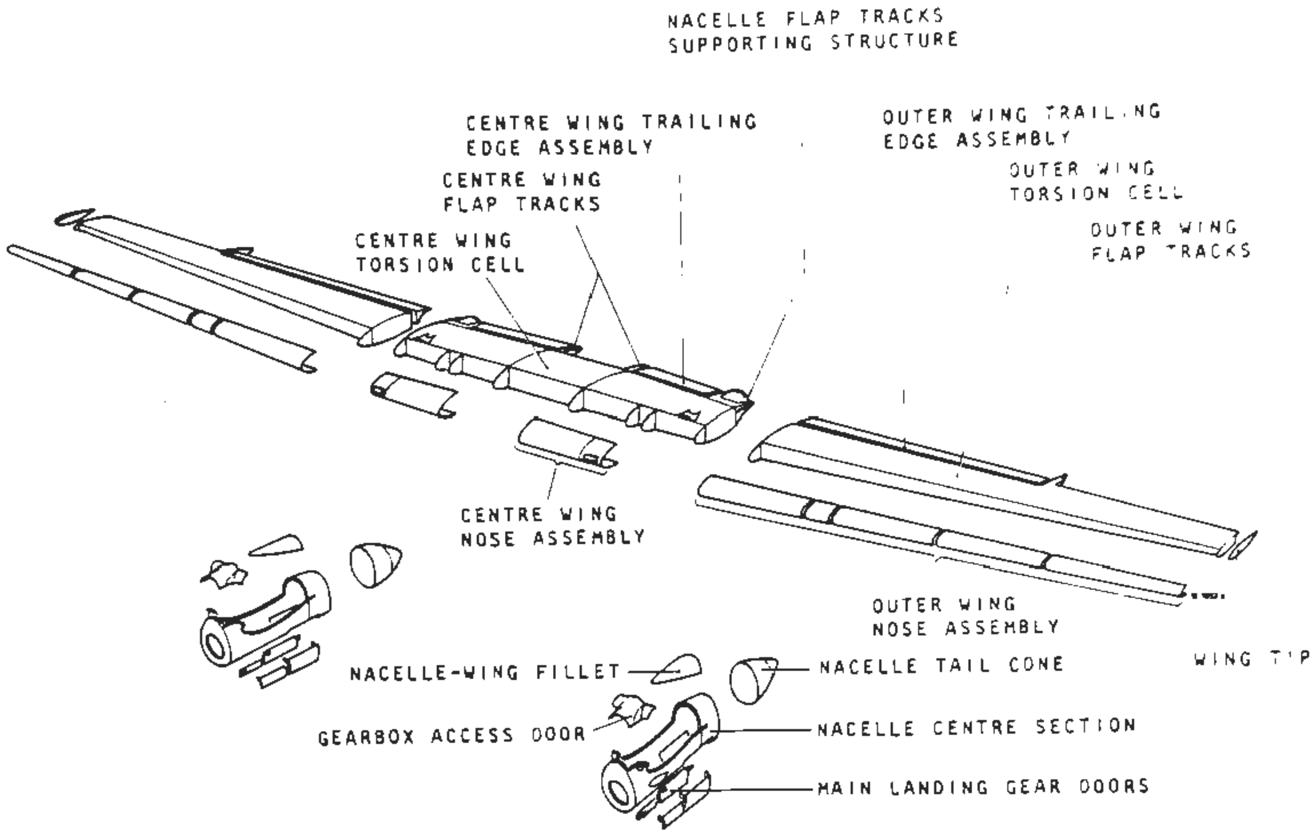
B. Flaps

The flaps on each wing are divided into two sections by the nacelles. The inner flap sections, which extend from the fuselage sides to the inboard side of the nacelles, and the outer flap sections, which extend from the outboard side of the nacelles to the wing ribs at stations 10030 are structurally identical and consist of transverse ribs which are spaced by a built-up type rear spar at the trailing edge and, by the forward station skin panel at the nose section.

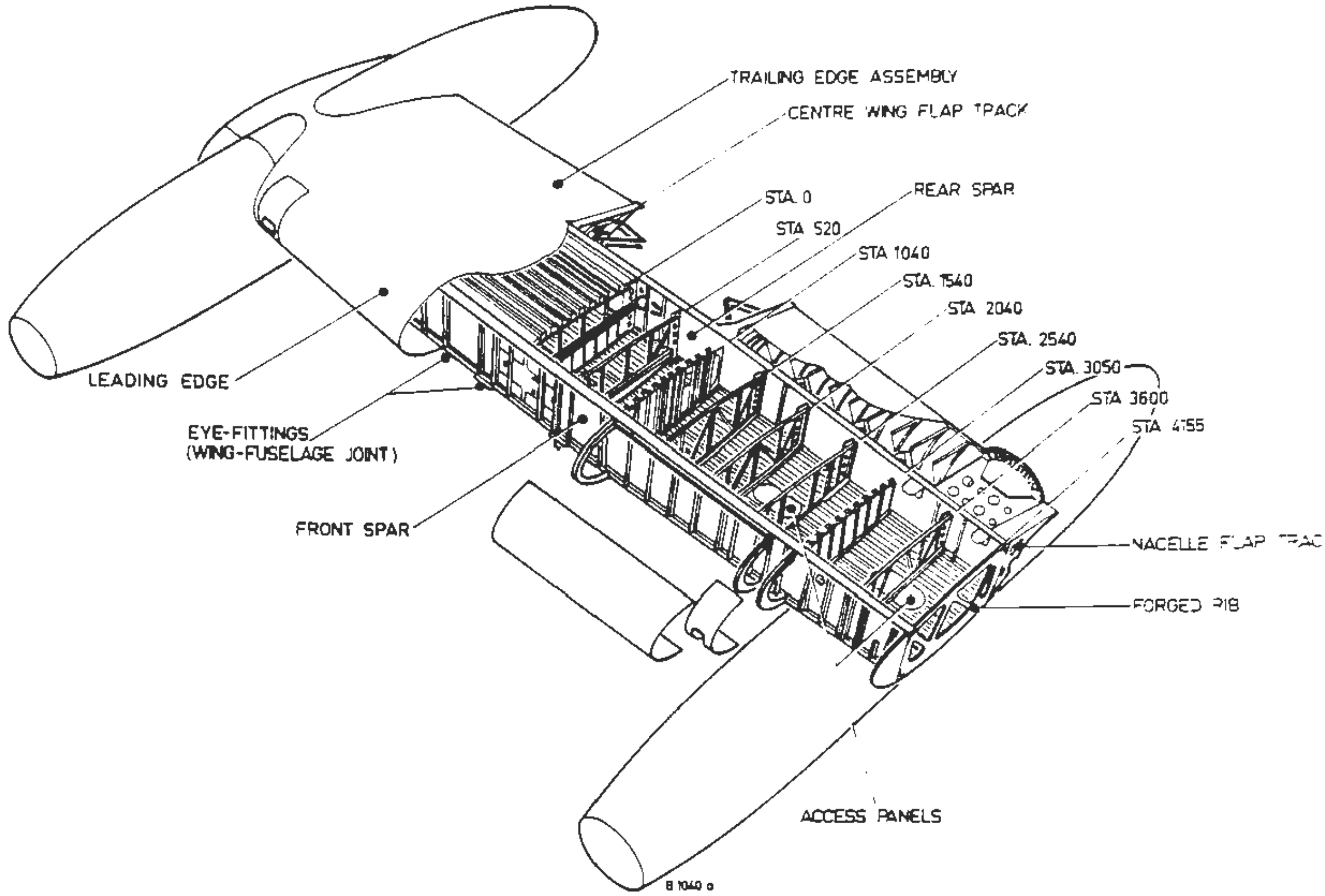
Upper and lower skin panels are riveted to the ribs between the nose section and the rear spar.
Stringers and doublers are Redux-bonded to the skin panels for greater strength and stiffness.

As the outer flaps Sta. 2435 a hinge fitting containing a spherical bearing protrudes through the lower skin panel, whilst at the end ribs of both flap sections forgings are mounted, containing a fork assembly for the flap drive mechanism and two rollers which guide the flaps along the fiaprails.

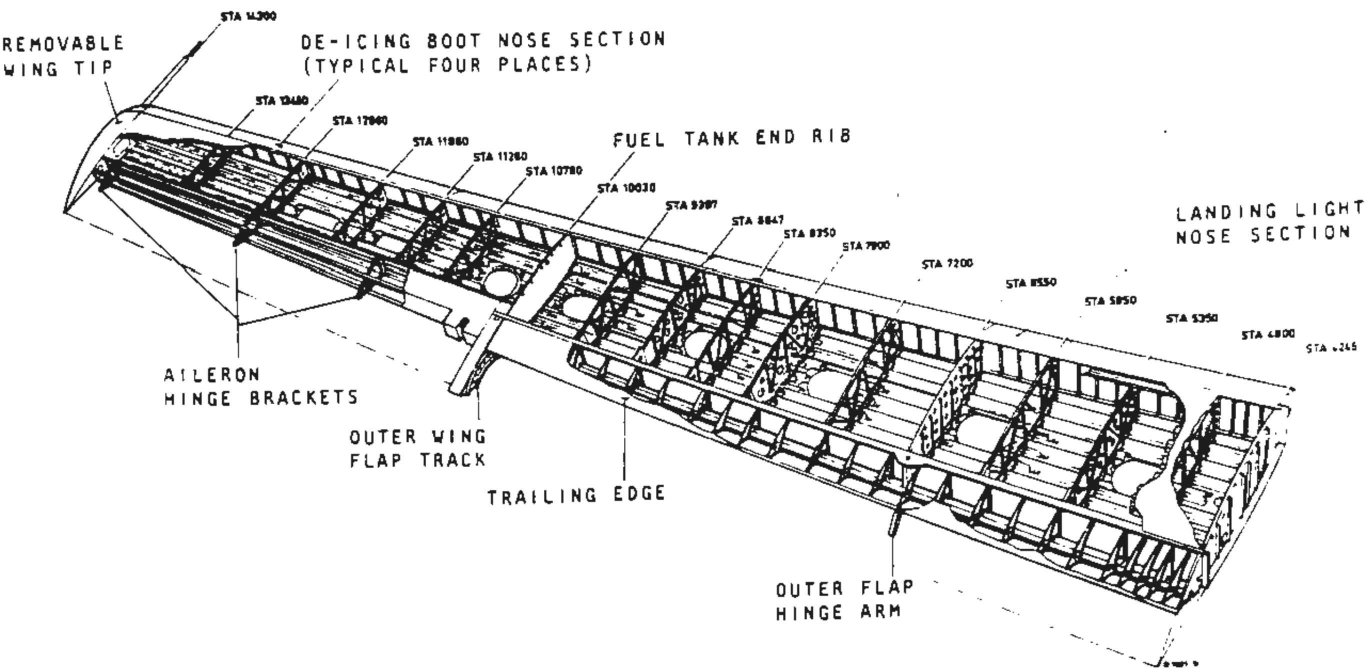
END



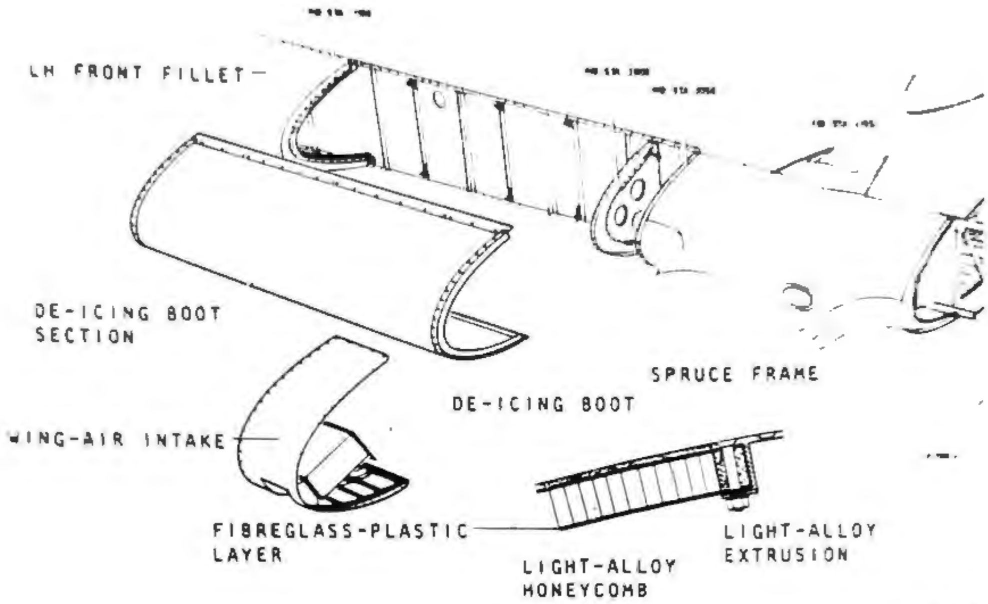
WING - STRUCTURAL BREAKDOWN



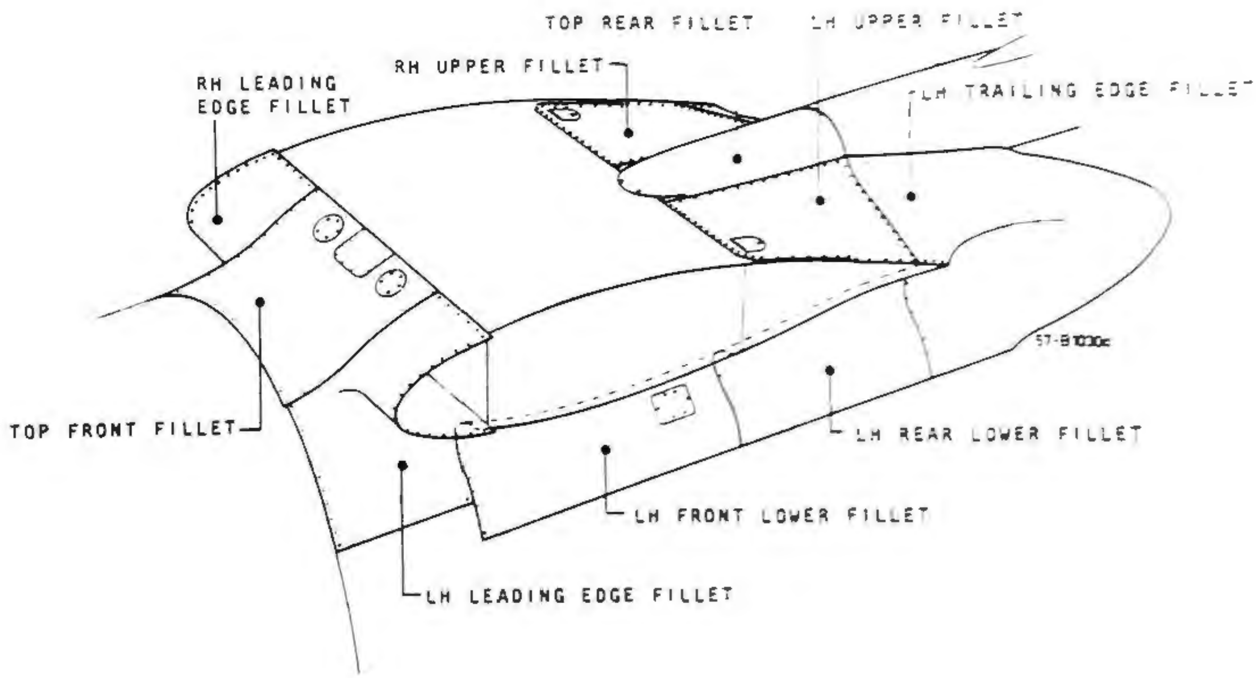
CENTRE WING STRUCTURE



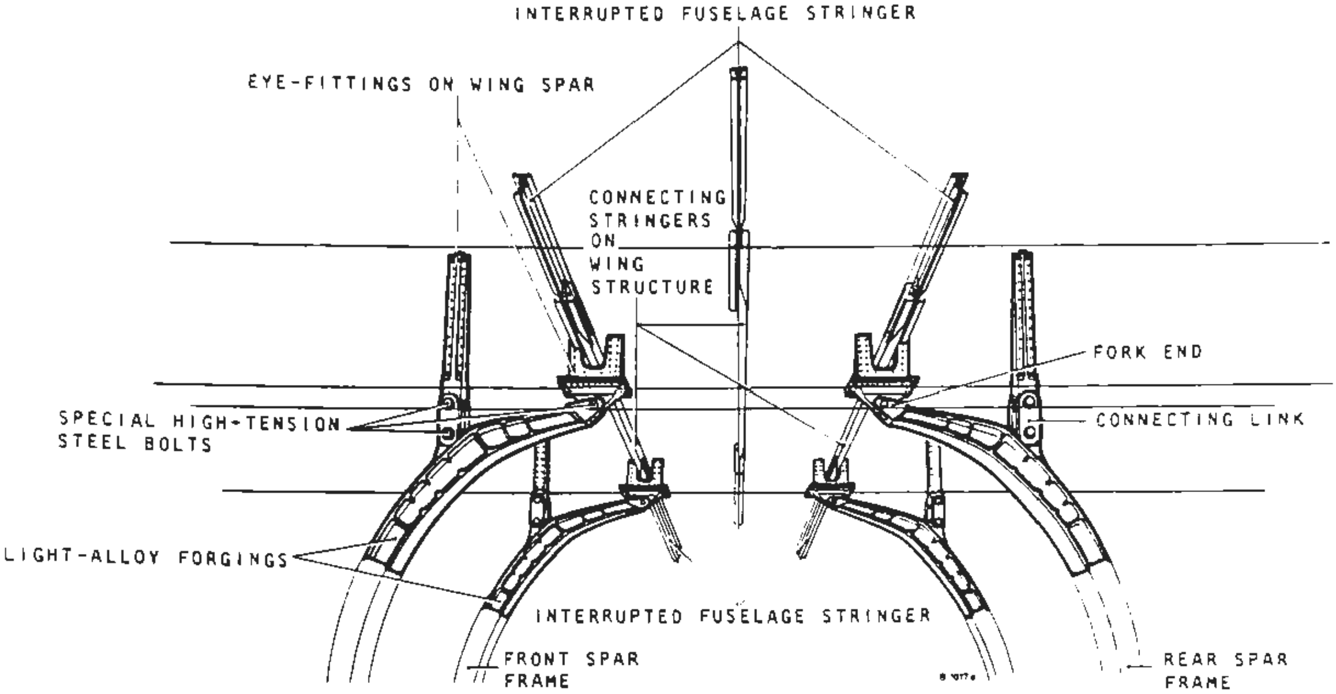
OUTER WING STRUCTURE



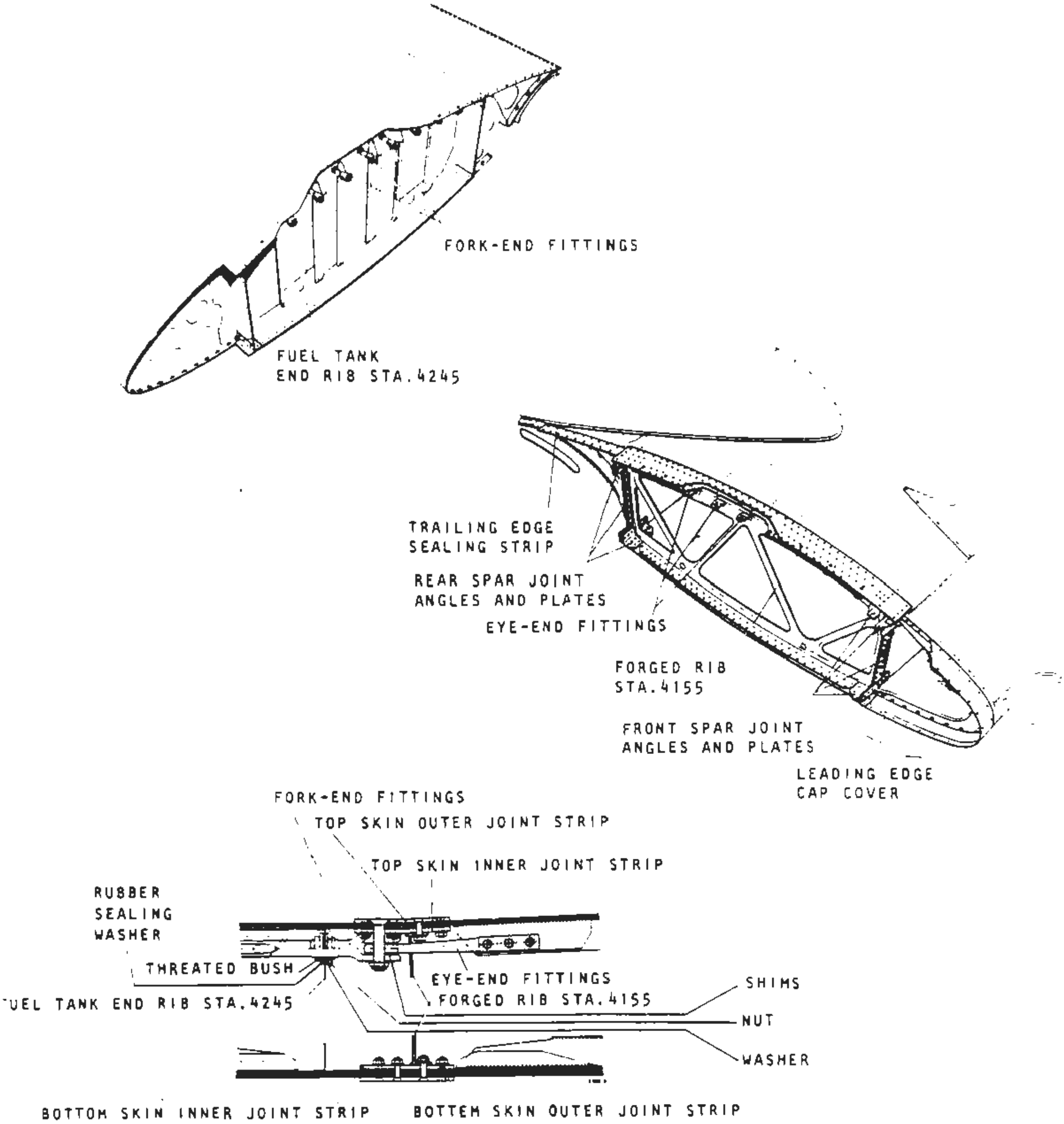
LEADING EDGE STRUCTURE



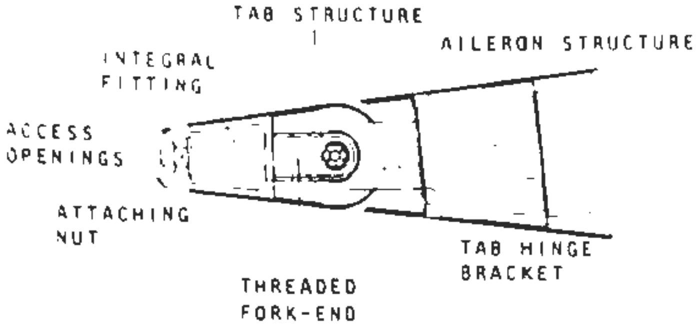
LEADING EDGE STRUCTURE & WING CENTRE SECTION TO FUSELAGE FILLETS



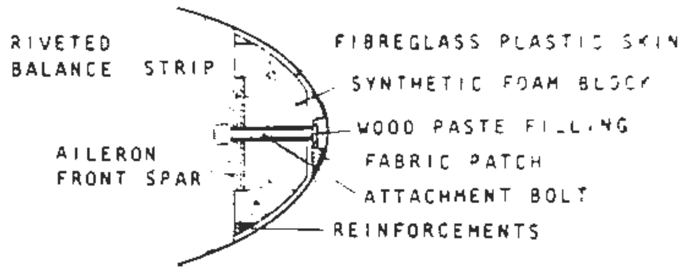
CENTRE WING TO FUSELAGE JOINT FITTINGS



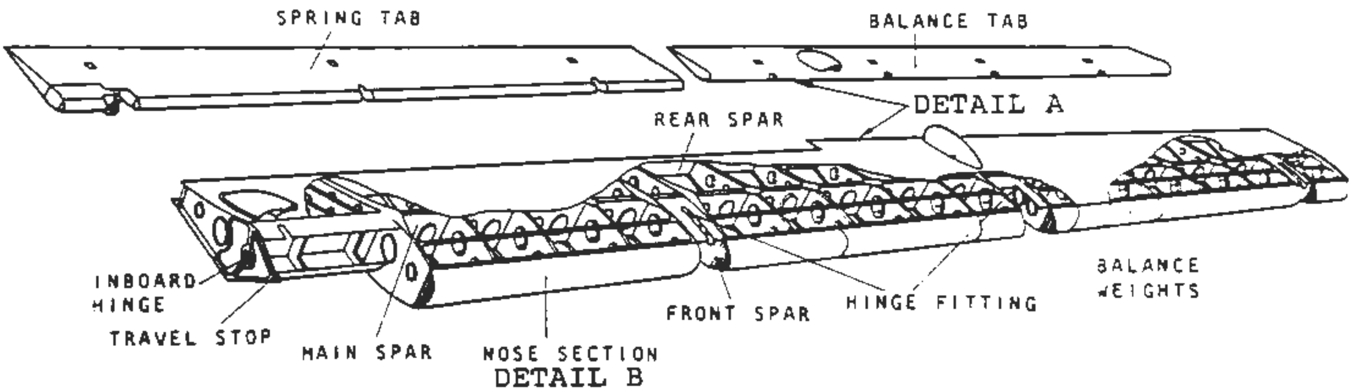
CENTRE WING TO OUTER WING JOINT



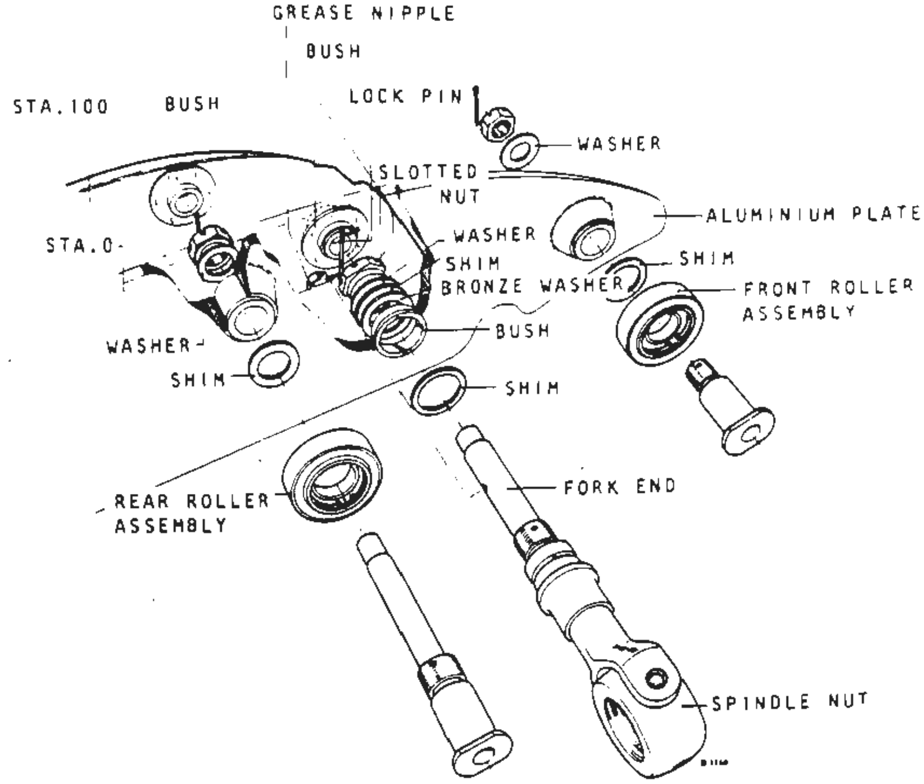
DETAIL A
TAB ATTACHMENT(TYP.)



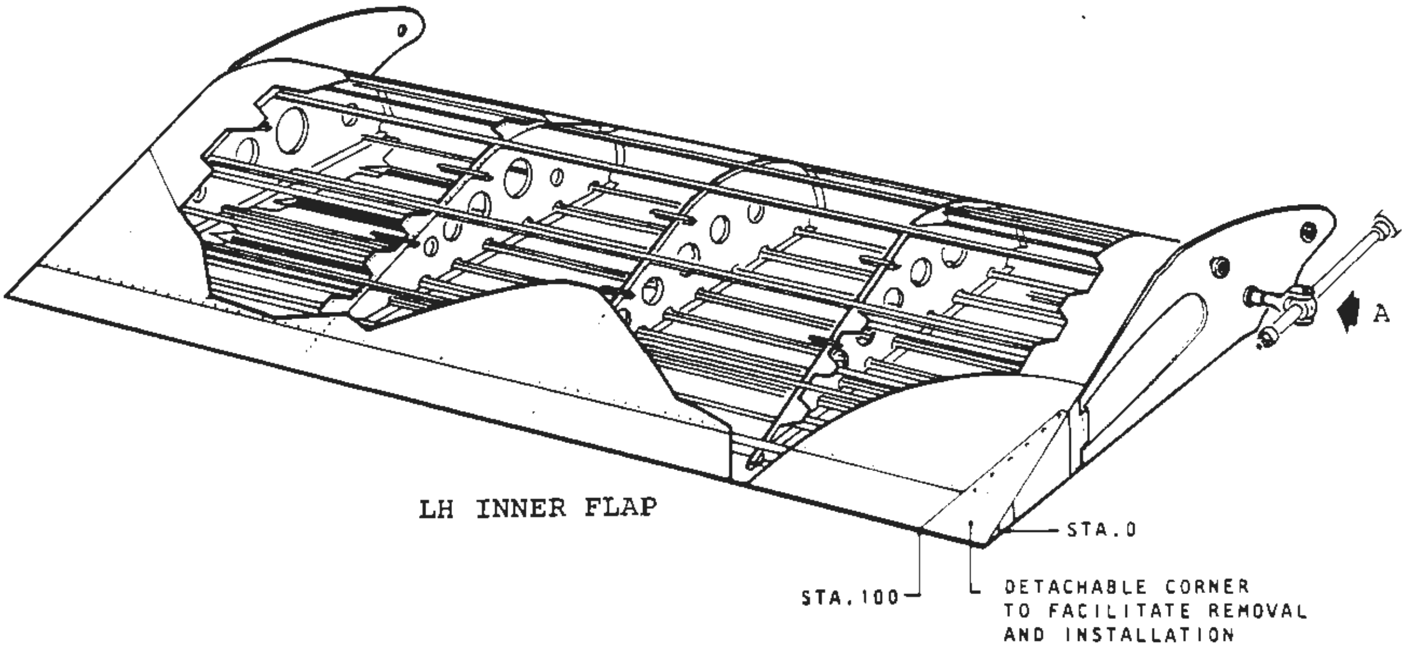
DETAIL B
SECTION THROUGH AILERON NOSE



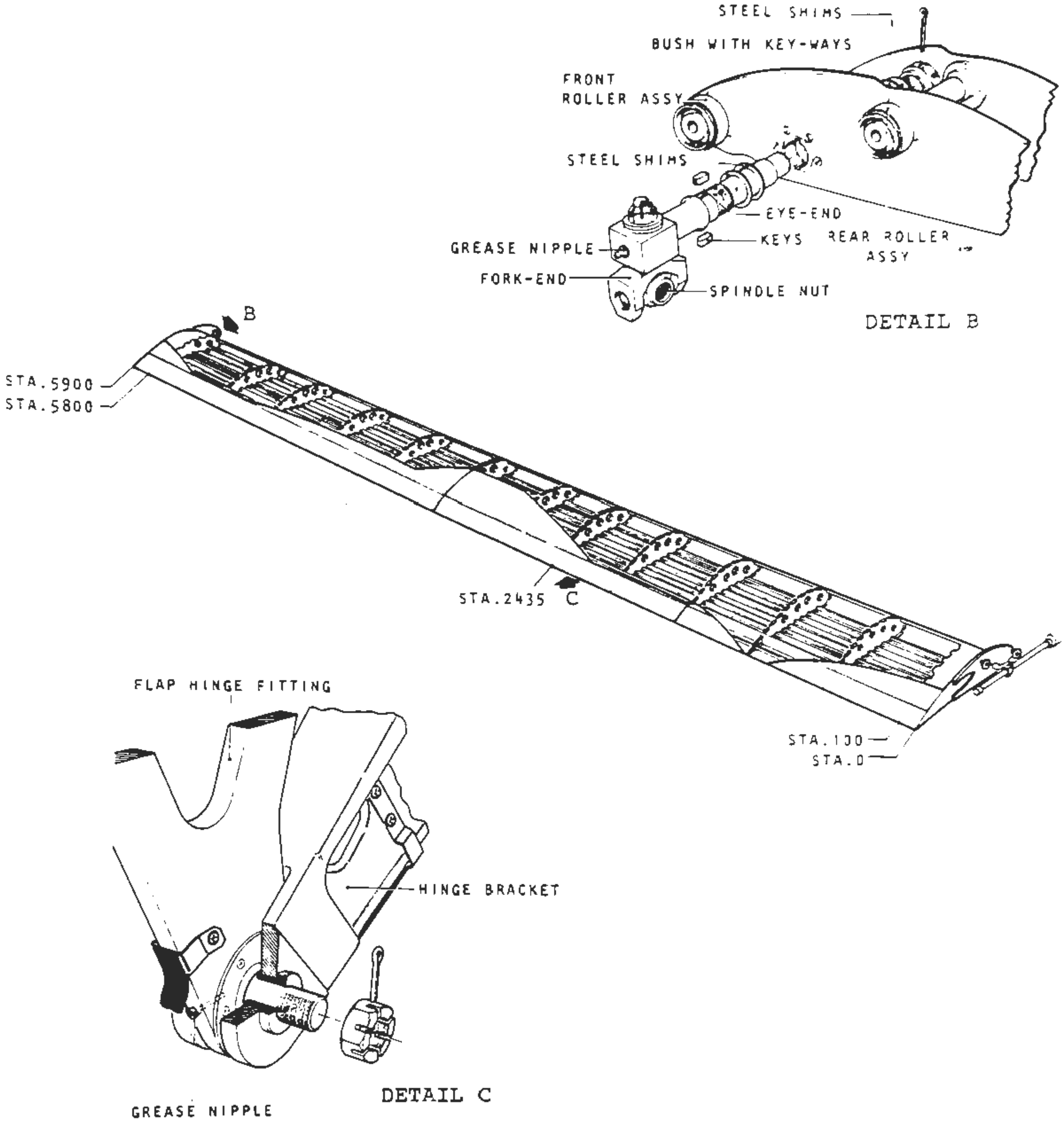
AILERON STRUCTURE



DETAIL A



INNER FLAP STRUCTURE



OUTER FLAP STRUCTURE

61

PROPELLER

61. PROPELLERS

61. PROPELLERS

00. GENERAL

This chapter contains descriptive information for the Dowty/Rotol propeller installations as fitted to Rolls-Royce Dart 7 engines.

This installation consists of a spinner-enclosed four bladed propeller, provided with a hydraulically operated variable pitch mechanism which is electrically and mechanically controlled. The variable pitch mechanism consists of a hydraulically operated piston, which moves in a cylinder secured to the front of the propeller hub. The piston is connected by a mechanical linkage to pins on the base of each blade. Linear movement of the piston is thus converted into angular movement of the blades. Oil pressure for operation of the piston is supplied from the engine high pressure oil system, and is boosted by an engine-driven pump in the propeller controller unit (PCU). Oil is fed from this unit to the cylinder via three oil lines arranged as concentric tubes within the bore of the engine (propeller) shaft. Pitch change oil pressure is conveyed through the innermost and centre tubes, (decrease and increase pitch line) while the outer tube (third oil line) is used to withdraw the flight fine lock as described below.

The PCU is interconnected with the engine controls and governs the selected engine speed by varying the power absorption characteristics of the propeller. This is accomplished by changing the pitch angle of the blades. A centrifugal governor controls a piston valve which regulates the oil supply to the pitch change mechanism. The pitch range is from ground fine pitch at zero degrees to fully feathered at 87 degrees, these pitch positions are determined by permanent stops. A positive mechanical pitch stop "Flight Fine Lock" is provided at approximately 20 degrees, while an additional mechanical pitch stop "Cruise Lock" is provided at 32 degrees. During take-off and flight, the flight fine lock automatically engages when the propeller pitch increases beyond the stop settings and can be disengaged when removal solenoids in the propeller controller unit are energised. The ground fine pitch is provided to minimize the starting and ground idling loads and thus to prevent overheating of the engine. It also provides a useful braking effect during the landing run because of the high windmilling drag.

The flight fine lock is incorporated to prevent excessive drag in case the propeller tends to fine off towards ground fine pitch during flight. It is hydraulically removed by oil pressure in the third oil line. Oil pressure is admitted only when the flight fine lock removal solenoid in the PCU is energised. The flight fine lock removal solenoids of both propellers are wired in parallel, and can be energised by lifting either one or both power levers from the idle position and pulling them back against spring tension. The solenoids will remain energized upon release of the levers provided neither power lever is above the 14,000 rpm position. A warning horn operates if the ground fine pitch circuit is not activated, the right hand power lever is below the 14,000 rpm position and the airspeed is less than 55 knots IAS. Should the flight fine lock fail in flight, an electro-hydraulic stop is operated. This safety feature prevents the blade angle from decreasing below 18° ± 1°.

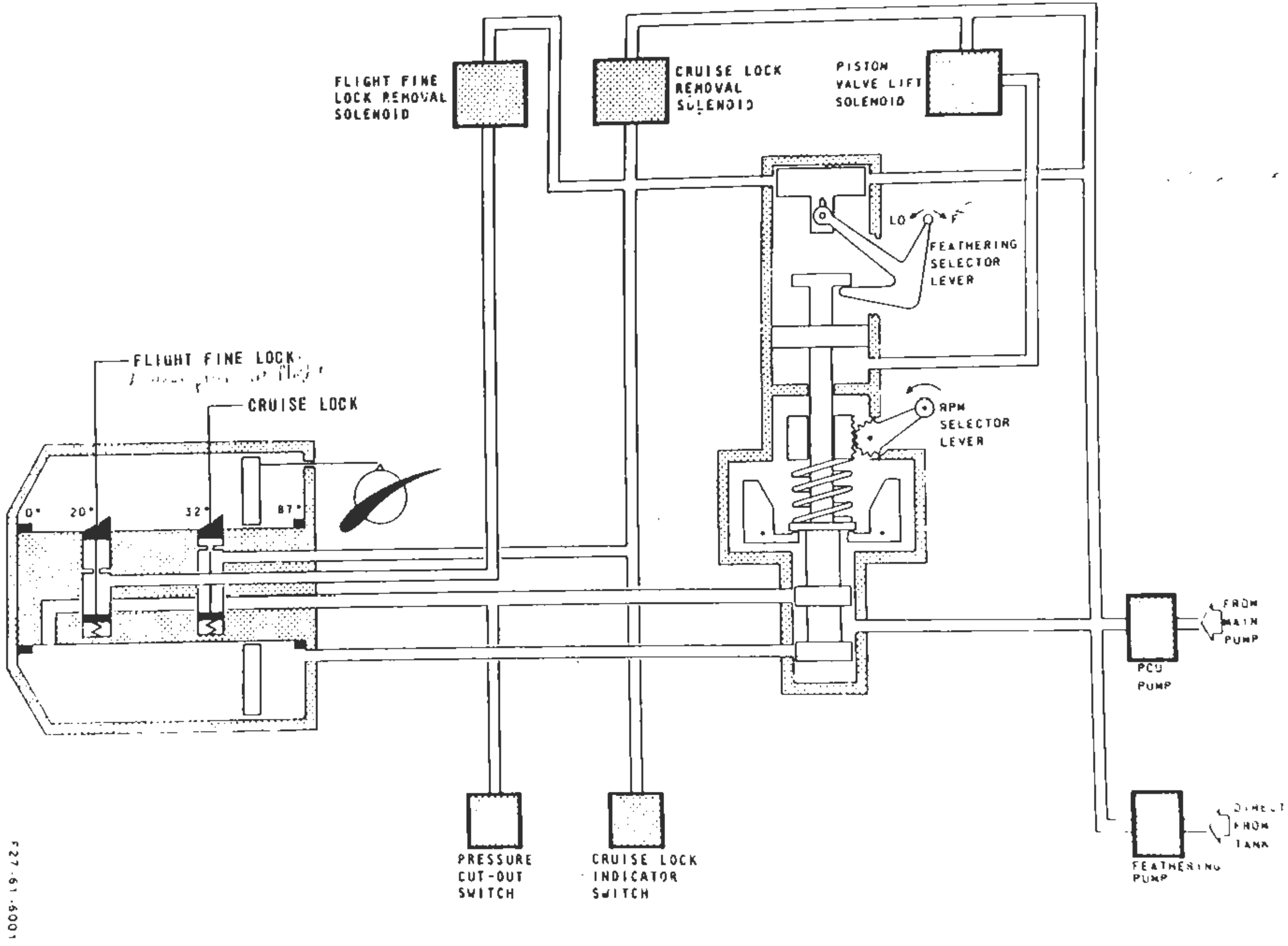
The cruise lock is incorporated to prevent uncontrolled fining off towards the flight fine lock at high forward speed. The cruise lock removal solenoids for both propellers are also in parallel and can only be energised when the blade angle hub switches of each propeller are closed.

The switches close at 34° + 1° and remain closed at all finer pitch angles. Since the hub switches are wired in series, the cruise lock circuit can only be completed if both propellers fine off to the hub switch setting. Should malfunction of the propeller occur, the engaged stops will thus prevent an excessively decreased pitch, a high drag and high engine rpm on one engine, while the other propeller is at normal pitch. The hub switches are also closed when the propeller is feathered, enabling the cruise lock circuit of the operative propeller to be completed. In case failure occurs in the electrical cruise lock removal circuit, the lock can be released manually by selecting LOCK-OUT on the high pressure cock. This movement operates an isolating valve in the PCU, which bypasses the cruise lock removal solenoid.

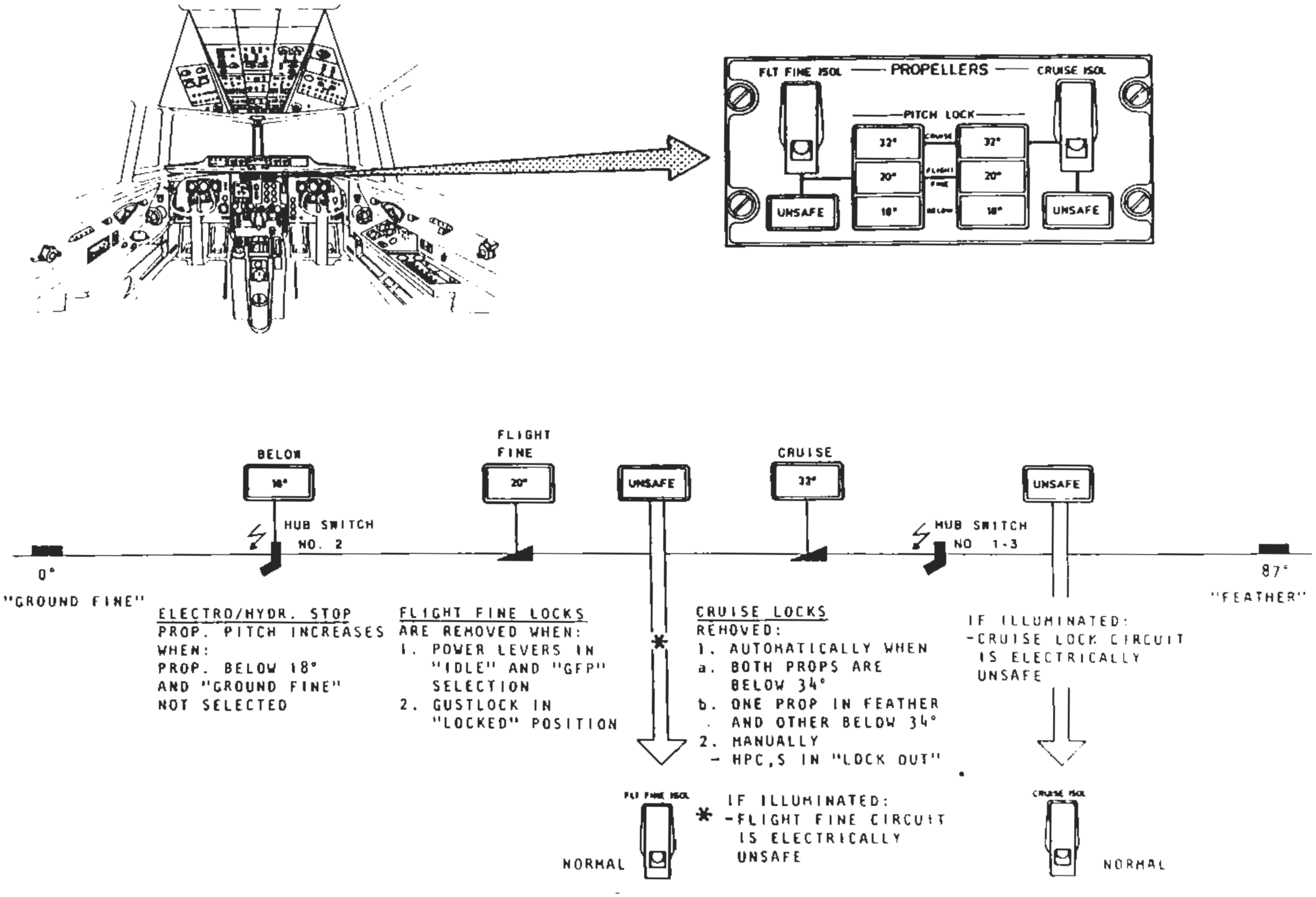
A feathering pump provides a sufficient high pressure for operations, for which the governor pump pressure is inadequate for instance feathering, or propeller exercising with the engine stationary. The propeller will be feathered automatically, when the torque pressure falls below a minimum value with the high pressure cock (HPC) in the OPEN or LOCK OUT position and the power lever above 12,800 rpm.
Manual feathering can be a accomplished by moving the HPC to the "FEATHER" position and operating a feathering button.

Indicator lights are provided in the cockpit to indicate correct operation of the various system components.

END



PROPELLER SYSTEM



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PROPELLER OPERATION

10.0 PROPELLER ASSEMBLY

The propeller assembly is comprised of the following components: hub group, blades, spinner, backplate, cylinder group and pitch lock unit.

10.1 Hub Group

The hub group is the foundation of the propeller and consists of a hub shell and a driving centre, secured together by bolts and nuts. It retains the propeller blades, and houses the hub contact switches and the link groups which rotate the blades about their axis.

A. Blades

The solid duralumin leading edge of the blade contains a recess on both faces for the rubber de-icing overshoe. The recess extends equally along both faces for approximately the inner two-thirds of the blade length. A taper roller bearing assembly is installed on the blade root by a retaining bolt which is tightened to a specific preload.

B. Spinner

The spinner is attached by quick-action, ejector-type locking devices to the back-plate which is secured to the de-icing slipring housing. These locking devices facilitate removal of the spinner by partly ejecting the spinner away from the back-plate during the unlocking operation.
Heater elements are cemented around the interior of the front portion of the spinner.
Current for these elements is taken from fixed contacts on the back-plate, which are connected to the sliprings, by spring-loaded plunger-contacts on the spinner.

10.2 Cylinder Group

The cylinder contains the hydraulically operated operating piston which is linked to the blade roots via the link group. Forward movement of the piston turns the blades to fine pitch while aft movement coarsens off the blades. The piston is provided with a steel liner and oil seals and travels on a collet sleeve which secures the cylinder to the propeller hub. Flanged steel rings secured to studs on the front and rear face of the piston form the different stops.
The flight fine lock and cruise lock stops are formed by steel rings secured to studs on the front face of the piston. The flight fine lock spigots are on the forward diameter of the piston liner while the cruise lock stop spigots are on the outer diameter of the flight fine stop. TWo laminated shims and solid shims are fitted between the stops and the piston to provide adjustment of the ground fine, flight fine and cruise lock angles and the feathered angle. Fine pitch oil can pass to the rear of the piston through holes drilled in the periphery of the collet sleeve, just forward of the cylinder fixing flange. The rear end of the cylinder is center bored. Four smaller bores in the rear wall permit passage of the link groups. Tapped holes around the periphery of the rear end of the cylinder receive studs which secure the balance weights which are fitted as necessary to balance the propeller.

The bore at the mouth of the cylinder is buttress threaded and slotted to receive a steel retaining nut and a rubbing ring which secure the cylinder cover of the pitch lock and piston support group in position.

Backplate, Slipring, and Brush Box Assemblies

The slipring group consists of a housing with three sliprings and is secured to the backplate group and to the rear of the propeller hub. The slipring group transmits the electrical current from the brush gear housing to the de-icing elements of the blades and spinner.
The brush gear housing group is secured to the engine reduction gear casing and incorporates a brush lock assembly which transmits the de-icing current to the propeller sliprings. It also incorporates sliprings with which the propeller hub switch(es) make(s) contact.

10.3 Pitch Lock Unit

The pitch lock unit is attached to the cylinder cover and can be withdrawn as a complete unit with the cylinder cover. The oil transfer sleeve is the foundation of the pitch lock unit and consists of three parts, which are secured together by studs and nuts. The sleeves are suitably drilled and bored to convey operation oil from the propeller oil tubes to the pitch lock unit and also to convey drain oil back to the propeller shaft.

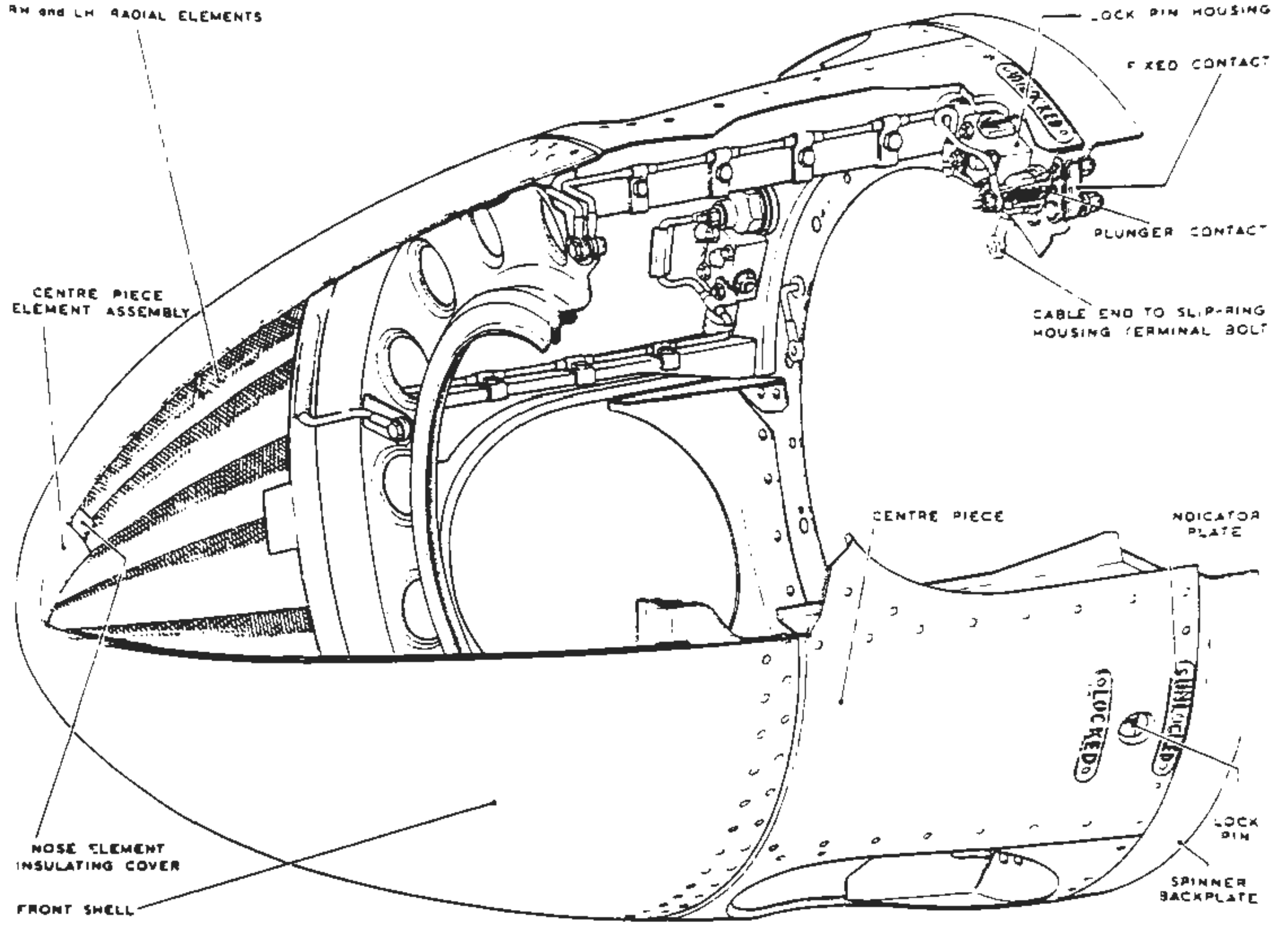
The rear oil transfer engages with serrations in the propeller hub retaining nut. A coarse oil pitch tube is fitted in the bore of the centre oil transfer, and a fine pitch oil tube is fitted into rear oil transfer. Three concentric and separate oil tubes are thus produced which register with the oil tubes in the engine shaft.
The front oil transfer sleeve extends through a bushing in the cylinder cover and is secured by a transfer sleeve nut. The nut and transfer sleeve are slotted and locked together by a lock plate, retained by a circlip.
An "increased pressure" valve which regulates the oil pressure to the lock cylinder is fitted in the bore of the front oil transfer sleeve. A spring collet is fitted over the lock cylinder and the front outer diameter of the centre oil transfer. It is slotted from the front end to about 80 percent of its length thereby forming inwards springing fingers. The fingers can be supported by a lock support which slides on the outer diameter of a lock support sleeve fitted around the front oil transfer sleeve.

The lock support moves in two stages and two stepped lands on its circumference allow the spring collet to be partially depressed in the first stage and further depressed in the second stage. Movement to the first stage is carried out by the lock cylinder (increased pressure) which unlatches the cruise lock and to the second stage by a pitch lock piston which unlatches the flight fine lock. A spring between the flange of the pitch lock cylinder and the lock support returns the support to its rearward position when oil pressure is released. The lock cylinder (increased pressure) encloses a lock piston (increased pressure) which is located against a shoulder on the front oil transfer sleeve and is held in position by the abutment of a pitch lock piston sleeve and the cylinder cover. Operating oil is introduced into the lock cylinder (increased pressure) via the "increase pressure" valve. This moves the cylinder and the lock support forward to unlatch the cruise lock.

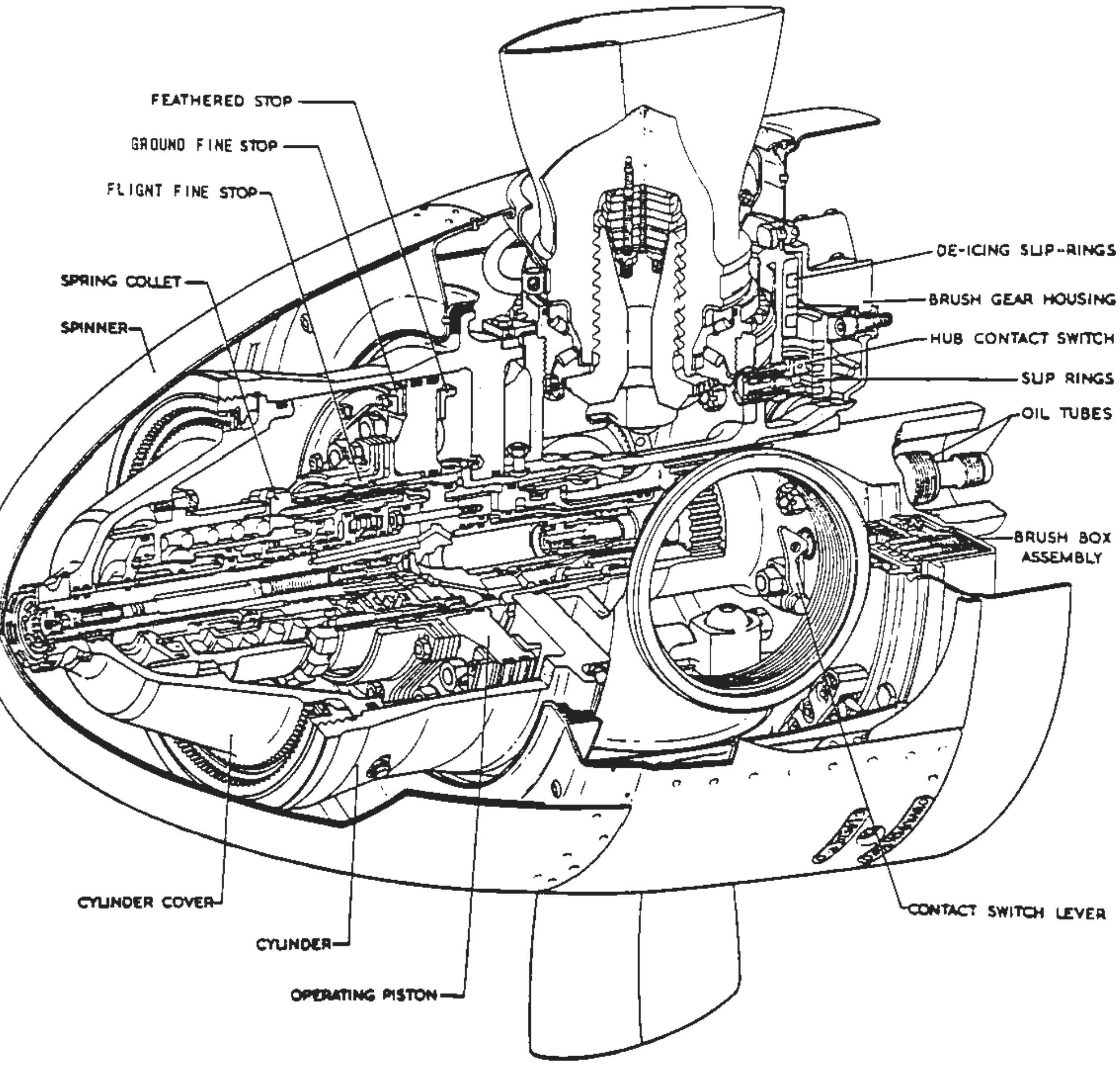
The cylinder is designed to travel only the distance sufficient to move the lock support to its first stage. The spring fitted between the lock piston (increased pressure) and the rear flange of the pitch lock cylinder returns the cylinder to its rearward position when the oil pressure is released. The pitch lock piston slides on the piston sleeve and is

situated in the pitch lock cylinder which is secured to the cylinder cover. The pitch lock piston nut which is secured to the rear end of the pitch lock shank seats in the internal flange on the lock support. During operation third oil line oil is supplied to the rear of the piston through drillings in the piston sleeve and the piston itself. This moves the piston and thus the lock support forward to unlatch the flight fine lock.

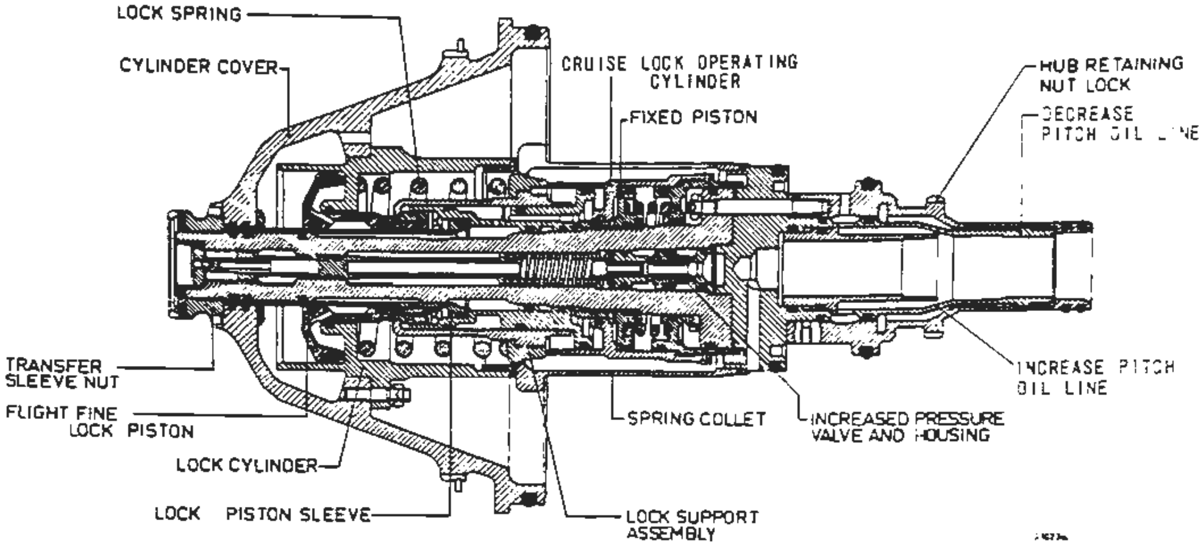
END



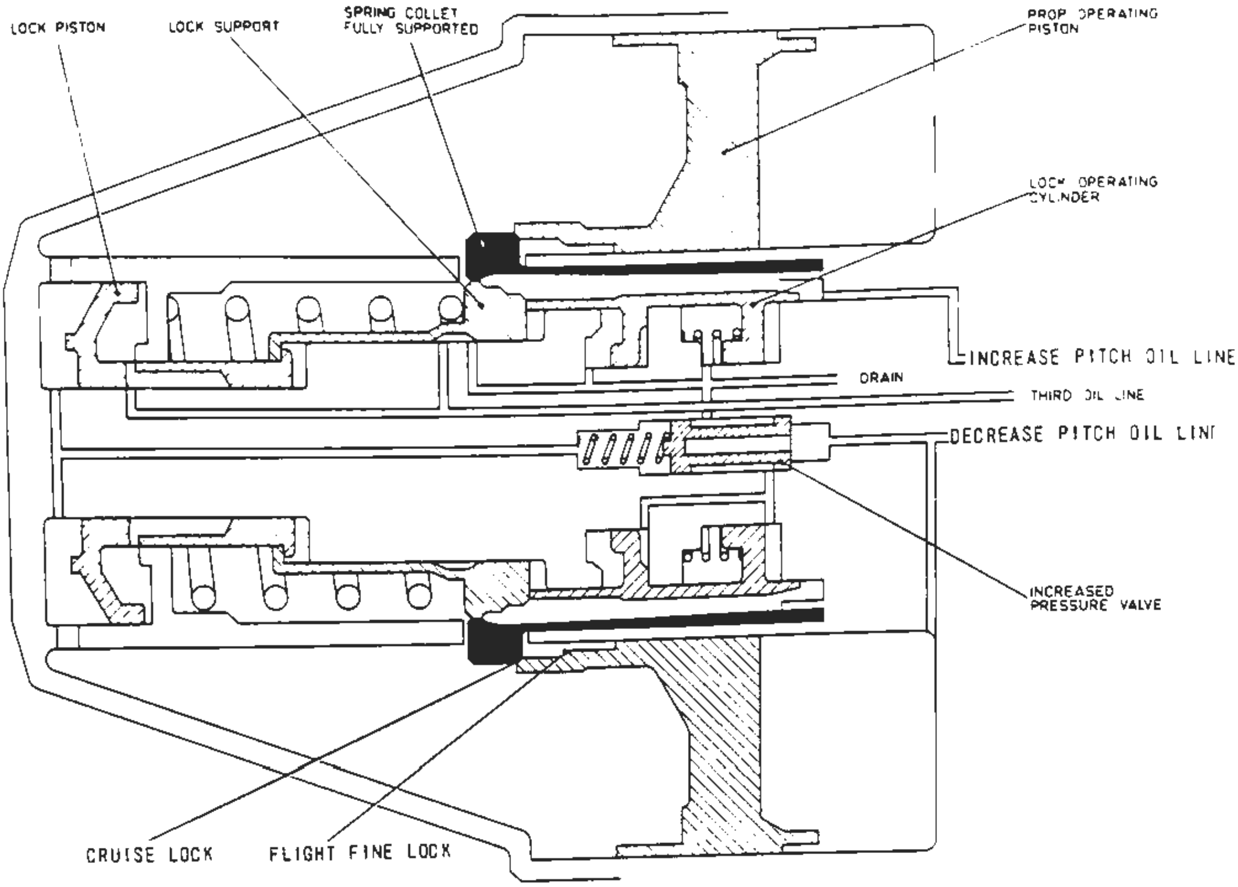
ROTOL PROPELLER SPINNER

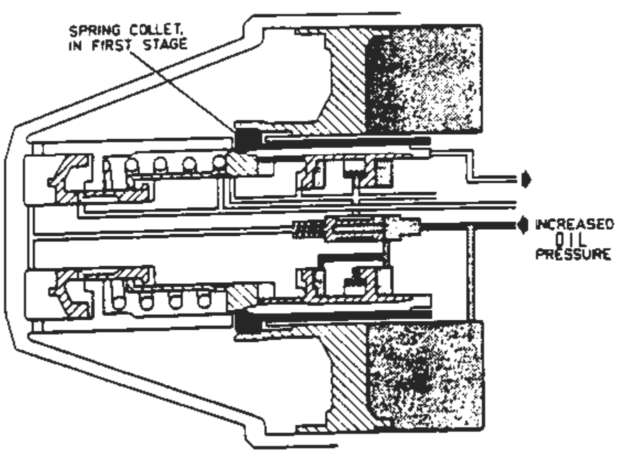


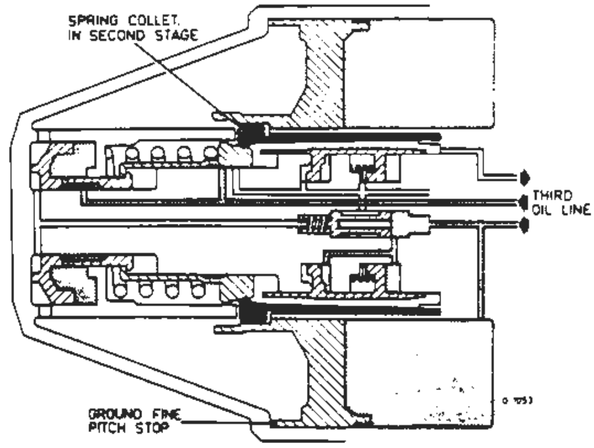
SECTIONED VIEW OF ROTOL PROPELLER



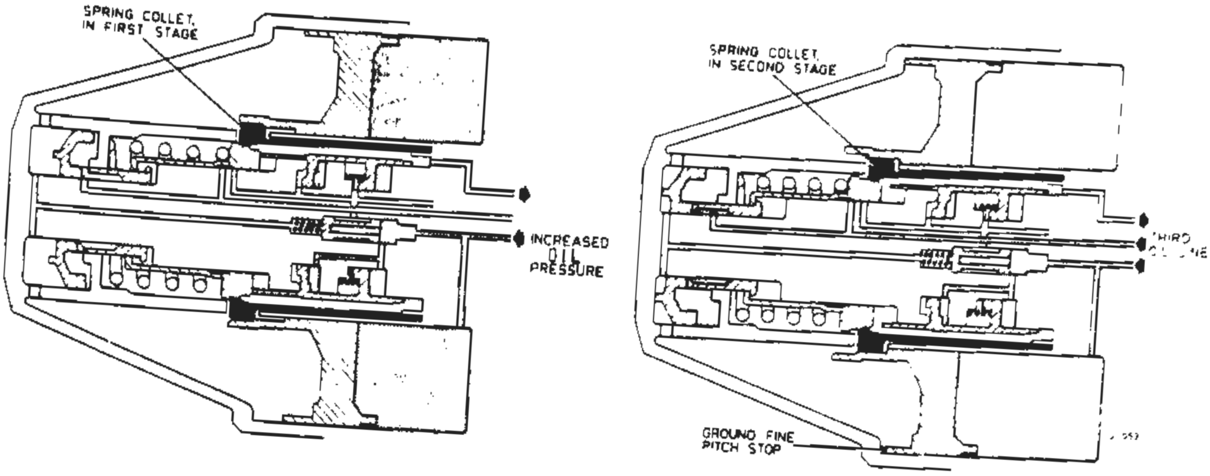
PROPELLER PITCH LOCK UNIT

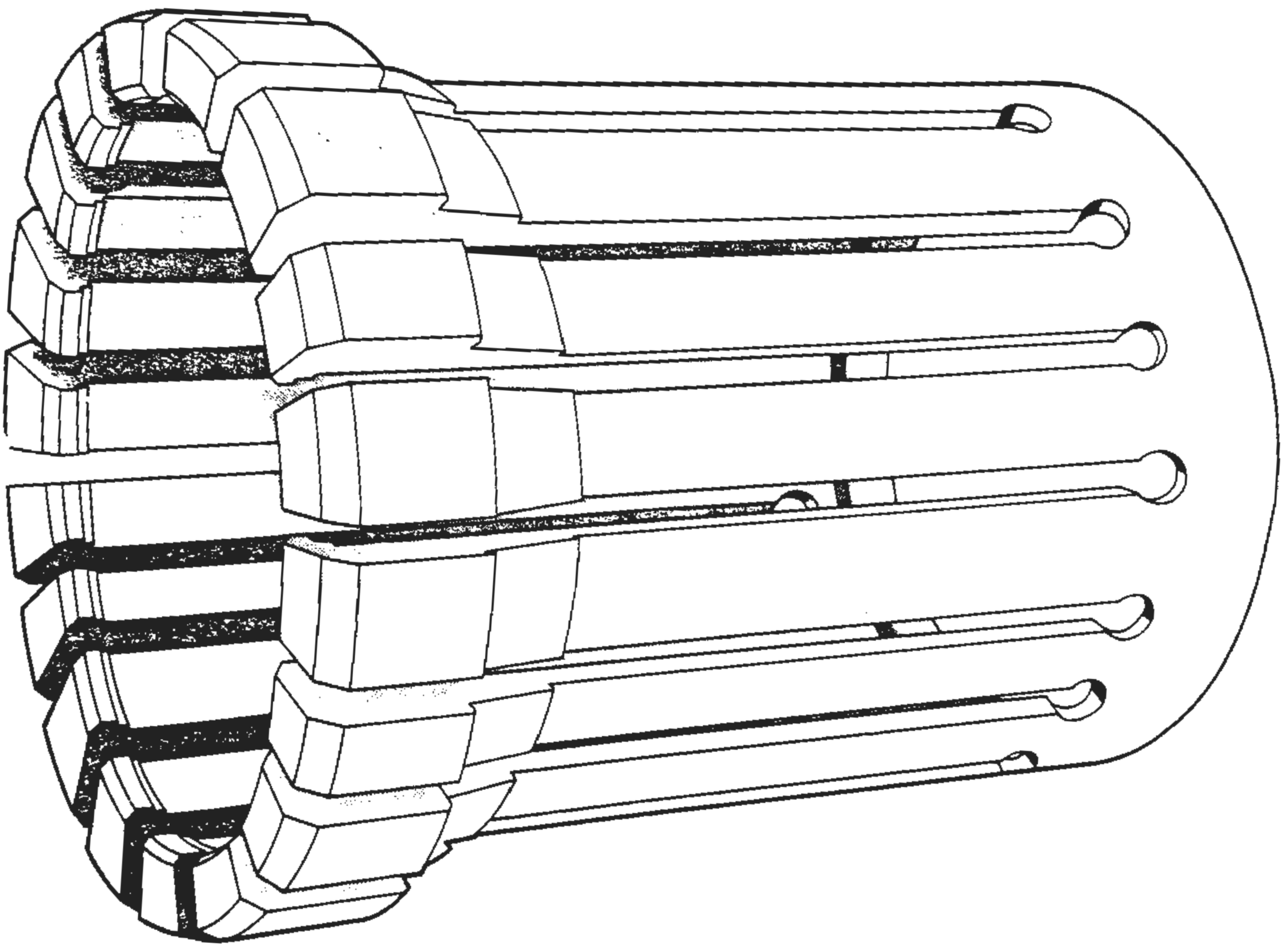




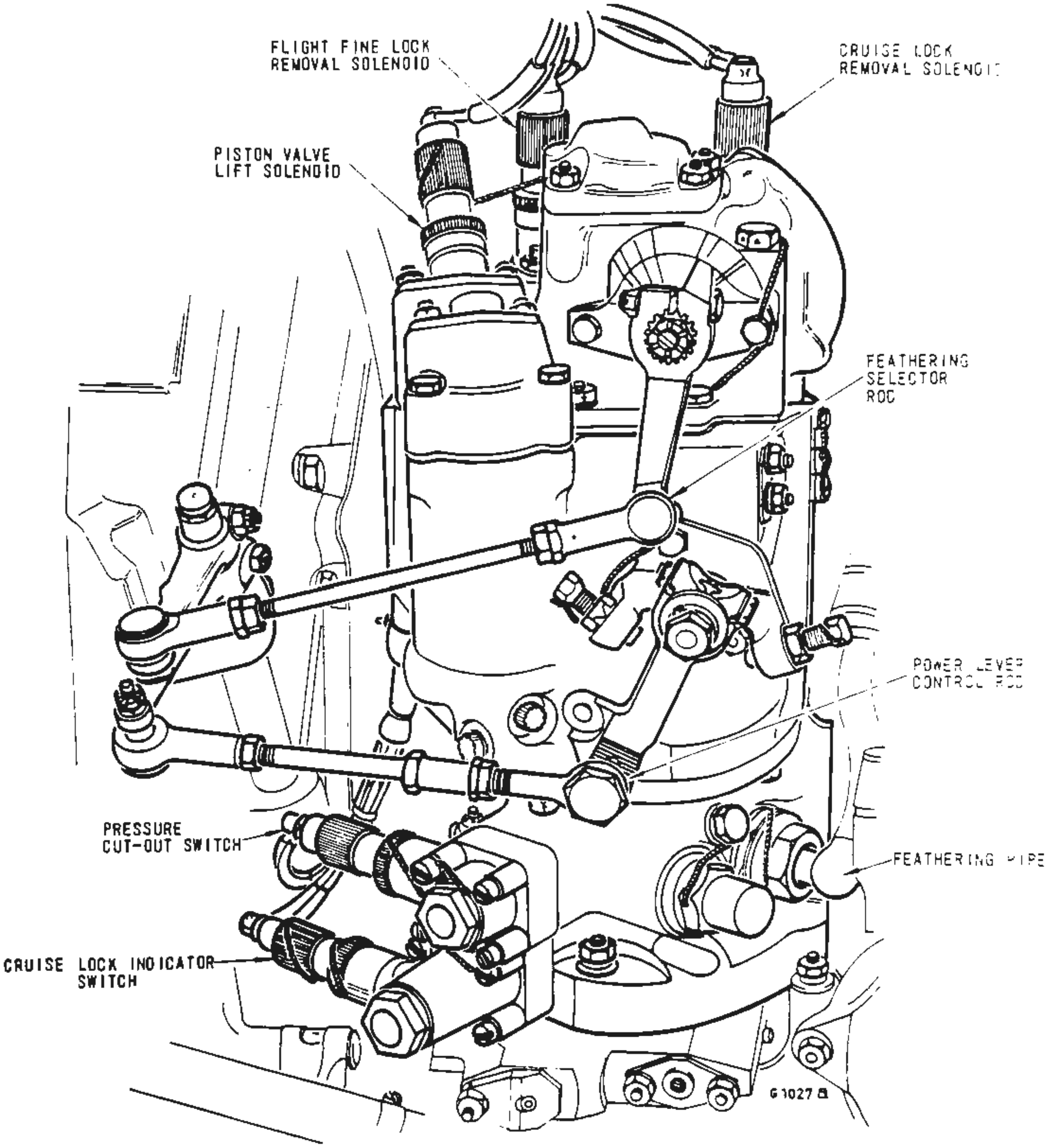


PROPELLER PITCH LOCK UNIT - PRINCIPLE OF OPERATION





SPRING COLLET



PROPELLER CONTROL UNIT

20.0 CONTROLLING

The PCU is mounted on the lower right hand side of the engine air intake casing. An integral gear pump and a spring-loaded governor unit are driven from the lower bevel gear housing. High pressure engine oil to the gear pump and controlled pressure oil to the changing mechanism passes through matching holes in the engine pad and the unit casing.

The governor unit consists of a flyweight assembly and a governor spring and is sensitive to changes in rpm. A piston valve attached to the governor unit, seals off the oil to the propeller operating piston when in neutral position, holding the blades at a given angle. The rpm at which the piston assumes this neutral position is determined by the loading of the governor spring: this loading is varied by an external power lever through a rack and pinion mechanism. The minimum loading of the governor spring is such that a minimum propeller speed of 11,000 rpm is required for the controller unit to maintain the engine speed selected by the power levers. Due to a "dead movement" built into the rack and pinion mechanism, the minimum loading of the governor spring is unaffected by the initial advance of the rpm lever.
Engine oil pressure is boosted by the PCU pump and delivered through a non-return valve to the central annular space between two lands on the piston valve. The pressure is controlled by a main relief valve set at a relief pressure of 600 psi pressure difference.
When the engine and thus the governor unit is rotating above the selected rpm, the piston valve is raised above the neutral position. High pressure oil is then admitted to the increase pitch oil line until the blades have coarsened sufficient to reduce rpm to the selected value.
When the engine speed is below the selected rpm, the piston valve is lowered below the neutral position, admitting oil pressure to the decrease pitch oil line until the blades have fined off sufficiently to raise engine speed to the selected rpm.
The piston valve can be raised independently of the governor control to feather the propeller.
This can be accomplished mechanically as a function of the HPC and hydraulically by an energized piston valve lift solenoid.

20.1 Conditions

The following conditions of governor operation are discussed; on speed, overspeed, underspeed, manual feathering, automatic feathering, unfeathering, automatic cruise lock removal, manual cruise lock removal, ground fine pitch and automatic coarsening.

A. On Speed Condition

In the on-speed condition the flyweight force will balance the governor spring force holding the piston valve in neutral postion. The piston valve closes both outlets and traps the oil within the piston operating cylinder. In response to a change in rpm, the flyweight force will overcome the force of the governor spring, thus causing the piston valve to move up or down, allowing oil to be directed to the front or rear of the propeller operating piston.
Oil from the opposite side of this piston is thereby allowed to bleed back to the controller unit pump inlet through the piston valve. When the selected engine speed is restored the governor is again in balance thus maintaining the desired blade angle.

B. Overspeed Condition

In the overspeed condition the propeller blade angle must be increased to reduce the propeller speed to the selected value. The flyweight force, which overcomes the force of the governor spring, raises the piston valve to a position where oil pressure is directed to the front of the propeller operating piston. At the same time, displaced oil from the rear of the piston is returned via the piston valve chamber to the inlet side of the controller unit pump. As the blades move to a higher pitch angle, the engine rpm decreases returning the governor flyweights to an on-speed condition.

C. Underspeed Condition

In the underspeed condition the propeller blade angle must be decreased to increase the propeller speed to the selected value. The governor spring force, which overcomes the flyweight force, lowers the piston valve to a position where oil pressure is directed to the rear of the propeller operating piston. At the same time, displaced oil from the front of the piston is returned via the piston valve chamber to inlet side of the controller pump. As the blades move to a lower pitch angle, the engine rpm increase, returning the governor flyweights to an on-speed condition.

D. Manual Feathering

Manual feathering is accomplished by moving the high pressure cock beyond the SHUT position to the FEATHER position, which mechanically raises the piston valve of the controller unit to direct oil pressure to the front of the propeller operating piston. Should mechanical operation fail, for instance due to control rod disruption, the oil passage to the front side of the propeller is also opened by oil pressure acting on the piston valve caused by electrically raising of the piston valve lift solenoid.
To complete the feathering operation the feathering pump must be switched on by pushing in the feathering knob. The switch is held automatically in that position by a solenoid, and returned to the centre "OFF" position when the fully feathered position is reached.

E. Automatic Feathering

Automatic feathering is actuated if an engine fails during takeoff and flight, provided that the power lever position is above 11,500 rpm (Pre SB 61-25) or 12,800 rpm (Post SB 61-25). Then the torque pressure of the engine drops below 50 psi, an engine torque switch will close completing a circuit to the feathering pump and the piston valve lift solenoid. The solenoid allows oil pressure to hydraulically raise the piston valve which opens the oil passage from the feathering pump to the front side of the propeller operating piston. During the start of this cycle the gear pump in the propeller controller assists the feathering pump. Oil from the rear side of the propeller operating piston is bled back to the gear pump inlet through the piston valve chamber. As soon as the propeller is feathered, the high pressure cock should be moved to FEATHER to prevent overheating of the feathering pump unit. This operation breaks the circuit to the feathering unit and the piston valve lift solenoid.
However, the piston valve is held mechanically in the raised position to maintain the propeller in the feathered position. To allow for landing gear warning horn operation and ground fine pitch selection of the other propeller, the power lever should be moved to IDLE.

F. Unfeathering in flight/on the ground

The propeller is unfeathered by moving the power lever to IDLE, and switching the ignition switches to ON. The feathering button is pulled out intermittently to obtain rpm increase. Moving the high pressure cock control to OPEN, allows the piston valve to be lowered to the underspeed condition, which opens an oil passage from the feathering pump to the rear of the propeller operating piston.

As engine speed increases the controller unit pump takes over and governs a constant speed. For all ground unfeathering operations it is essential to close the fine pitch relief valve by selecting LOCK-OUT with the high pressure cock control, before pulling out the feathering button. Otherwise, an excessive amount of oil will pass the fine pitch relief valve into the lubrication system, consequently flooding the engine.

G. Automatic Cruise Lock Removal

To remove the cruise lock an electrical circuit is completed by hub switches operated by cams on the blade roots when the blades reach a set angle (34°), or are in feathered position. This energizes the cruise lock removal solenoid in the PCU and allows oil pressure to hydraulically close the fine pitch relief valve.

H. Manual Cruise Lock Removal

When a cruise lock fails to remove for any electrical cause, the high pressure cock is to be moved to the LOCK-OUT position. This causes the solenoid isolating valve to be depressed to a position which directs oil to bypass the cruise lock removal solenoid.

The movement of the high pressure cock has no effect on the position of the high pressure valve itself but only operates the isolating valve.

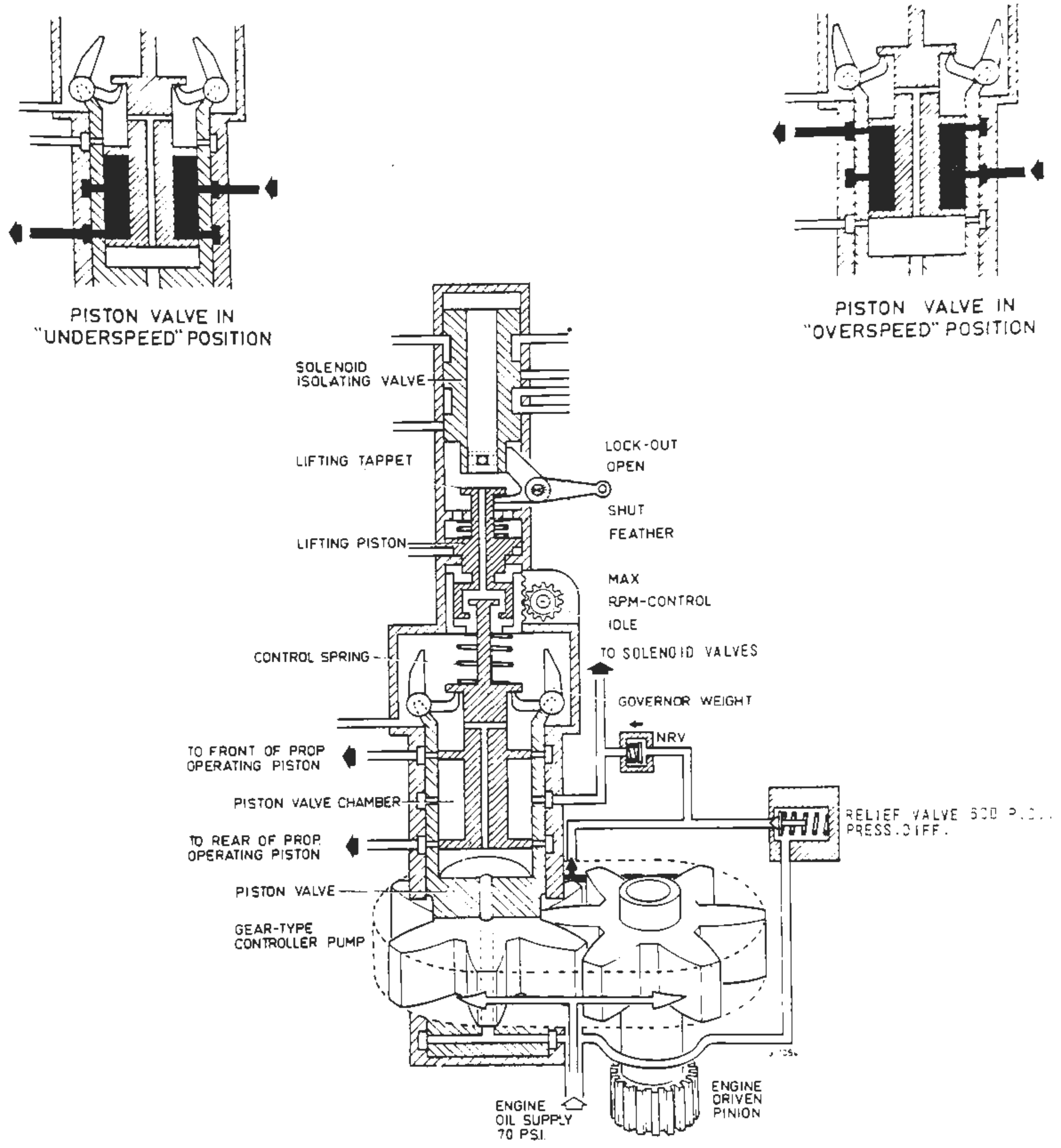
I. Ground Fine Pitch

To allow the propeller blades to fine off to ground fine pitch, the power levers are to be lifted from the IDLE positions and pulled back. This operation closes the ground fine pitch switches, which complete the flight fine lock remove circuit, and energizing the flight fine lock removal solenoid, each solenoid operates its third oil line valve which directs oil pressure to the third oil line. The oil pressure in the third oil line operates the flight fine lock removal piston.

J. Automatic Coarsening

The electrohydraulic safety pitch stop system prevents the blades from going into ground fine pitch, when the flight fine lock remove circuit is not activated and the flight fine lock fails. The propeller blade No. 2 is provided with a hub switch which is set to close at 18° ± 1° pitch angle. When closed it illuminates a BELOW LOCK warning light for that propeller. When the flight fine lock remove circuit is not activated, the closed hub switch completes a circuit to energize the piston valve lift solenoid. The piston valve is lifted and oil pressure is directed to the front of the blade operating piston, increasing the blade angle. This continues until the hub switch breaks. The propeller will then fine off again until the hub switch is remade. The propeller will therefore hunt over a small angular range around the 18° ± 1° position unless the blade angle is coarsened by an increase in aircraft forward speed or engine power.

END



PROPELLER CONTROL UNIT - PRINCIPLE OF OPERATION

21.0 OPERATION

21.1 Cruise Lock Operation

The cruise lock is unlatched automatically by hub switches if the propeller control system is serviceable i.e. fine pitch oil pressure available.
When the hub switches are closed, the cruise lock removal solenoids in each PCU are energized.
This allows high pressure oil from the PCU pump to "back-up" and close the fine pitch relief valve.
This valve normally limits the decrease pitch line pressure to 180 psi differential.
This pressure of 180 psi differential is sufficient for normal fine pitch operation as the centrifugal turning moment (C.T.M.) is acting on the blades and endeavouring to turn them into fine pitch whenever the propeller is rotating.

When the fine pitch relief valves are closed, pressure will commence to build up in the decrease pitch lines, as the propeller operating pistons are now held by the cruise locks which form an obstruction in the forward travel of the propeller operating pistons.
This consequent increase in oil pressure in the decrease pitch oil lines opens the spring-loaded increased pressure valves in each oil-transfer sleeve.
These valves are set to operate at a differential pressure of approximately 300 psi.
When the increased pressure valves are opened, pressure oil is admitted to operate the lock operating cylinders.
The lock operating cylinders, which are abutting the rear faces of the lock supports, move forward and force the lock supports forward against the springs thus unlatching the first stage of the lock i.e. cruise lock.
The lock operating cylinder is designed to travel only the required distance move the lock to its first stage.

Oil displaced by the lock operating cylinder passes to drain through annular ducts in the increased pressure valve.
In the reverse operation i.e. when the cruise locks are latched, the increased fine pitch relief valve oil pressure reverts to normal fine pitch pressure (180 psi) when the flight fine lock removal solenoids are de-energized and the fine pitch relief valves are no longer backed up.
The increased pressure valves under their spring loading now move rearward and open all ducts to allow the oil in the lock operating cylinders to pass to drain.
A lock cylinder spring fitted in the lock cylinder returns the cylinder to its rearward position.
The lock support is also moved rearwards under the pressure of the lock spring, to fully support the spring collet.

A. Cruise Lock Removal Solenoid

To unlatch the cruise lock, an electrical circuit is completed by hub-switches operated by cams fitted on the blade roots when the propeller pitch fines off to a set angle.
The switches are duplicated to safeguard against the possibility of failure.
Completing this circuit energizes a solenoid operated valve (cruise lock removal solenoid) in the controller unit which directs high pressure oil from the controller unit pump to close the fine pitch relief valve.

The consequent increase in decrease pitch line oil pressure moves the increased pressure valve and operates the pitch lock cylinder.
The hub switches of both propellers are wired in series to prevent the cruise lock of one propeller from being unlatched before the blade angle of the other propeller has fined off to the hub switch setting angle.
Provisions are made to close these switches of a propeller when it is feathered, to allow the circuit to be completed when the other propeller reaches the cruise lock.

B. Cruise Lock Indicator Switch

The cruise lock indicator switch operates a blue warning light to indicate that the cruise lock is removed.
The light illuminates when the lock is removed and remains on at all finer pitch angles.
The lock indicator switch is operated hydraulically by a rise of oil pressure in the third-oil-line low pressure circulation.
When the cruise lock is latched, there is a flow of oil from a bleed in the PCU, via the lock indicator switch, the fine pitch relief valve, the third-oil-line valve and into the third-oil-line to drain, via an annular vent in the pitch-lock unit.
When the lock support moves to unlatch the cruise lock (first stage), the annular vent to drain becomes closed, and pressure consequently builds up in the third-oil-line.
A low pressure relief valve is incorporated to ensure the pressure will not rise sufficiently to operate the flight fine lock.
The movement of the cruise lock relief valve servo-piston when the cruise lock removal solenoid is energized, also causes a rise of pressure in the bleed circulation to operate the lock indicator switch.
The spring loaded lock indicator switch opens the warning light circuit when the pressure drops, i.e. when the cruise lock is latched.
The flow of oil for this lock indicator switch operation is taken from the engine oil system at 70 psi, therefore it should be noted that with the engines stationary there will be no oil pressure available for this indicator system and the blue lights will be out.

C. Solenoid Isolating Valve

Used for manual withdrawal of the cruise lock, this piston valve is fitted in the top of the controller unit and is operated mechanically via the HPC lever in the cockpit.
The HPC lever has a LOCK-OUT position by which the valve is lowered to a position which directs oil pressure from the PCU to hydraulically close the fine pitch relief valve.
This oil pressure circulation by-passes the cruise lock removal solenoid.
The closing of the fine pitch relief valve causes the cruise lock to unlatch in the normal manner.
Movement of the HPC lever from the OPEN to the LOCK-OUT position has no effect on the high pressure cock itself but only operates the solenoid isolating valve.

21.2 <u>Flight Fine Lock Operation</u>

Oil pressure from the PCU pump is admitted via the previously energised cruise lock removal solenoid (or via the solenoid-isolating valve if LOCK-OUT has been selected), into the lock operating oil line by the operation of the third-oil-line-valve.
Operation of the third-oil-line-valve is controlled by the energizing of

the flight lock removal solenoid.
The flight fine lock is unlatched by the admittance of oil pressure from the PCU pump into the third oil line.
The forward movement of the flight fine lock piston, under the influence of the oil pressure, removes the mechanical support from the spring collet, i.e. the lock is unlatched.
The propeller operating piston, under fine pitch oil pressure (PCU piston valve in the "underspeed" position), may then travel forward, depress the spring collet, and move over it into the Ground Fine Pitch position.

A. Third Oil Line Valve

The Flight Fine Lock is unlatched by the admittance of oil pressure into the third oil line.
The admittance of oil pressure into this line is governed by a third oil line valve, embodied in the PCU, which isolates the pressure side of the PCU pump from the third oil line.
The third oil line valve consists of a double-headed valve on a common stem together with seatings in the valve.
The double-headed valve stem abuts a small piston, and is spring-loaded to remain in its normal closed position.
With the valve in its normal position, the third-oil-line is isolated from the pump pressure side of the PCU by one valve which is closed on its seating, but is open to the low pressure drain side of the PCU via the other valve, which is off its seating.
The cruise lock removal solenoid incorporated in the PCU allows the third oil line valve to be hydraulically actuated via the previously energized cruise lock removal solenoid (or via the solenoid isolating valve if LOCK-OUT has been selected), to admit pressure oil into the lock operating oil line.

B. Flight Fine Lock Removal Solenoid

When the Flight Fine Lock Removal solenoid of the controller unit is energized, controller unit oil pressure is directed to one side of the piston of the third oil line valve, which then moves and operates the double-headed valve.
Movement of the valve opens one seating, which allows direct access of controller unit oil pressure into the third oil line and, at the same time closes the other seating to shut off the drain line.
Oil pressure in the third oil line enters the rear side of the flight fine lock piston which, together with its lock support, is moved forward, thus unlatching the flight fine lock.
When the solenoid is de-energized, oil pressure to the third oil line valve piston is shut off.
The spring-loaded double-headed valve then returns to its normal position.
The oil displaced by the spring-loaded pitch lock piston when it returns to its rearward, collet-supporting position, is directed via the valve into the low pressure drain circulation of the PCU.

21.3 Electro-hydraulic Pitch Stop

Oil pressure from the PCU pump is admitted into the coarse pitch oil line by the lifting of the controller unit piston valve to the "overspeed" position.
The piston valve is hydraulically lifted to the "overspeed" position by the operation of the piston valve lift solenoid.
The piston valve lift solenoid will be energized by closing of the

hub switch on blade No. 2 (During ground operations this circuit is rendered inoperative when the Ground Fine Pitch circuit is energized).
The electro-hydraulic stop circuit is set to come into operation whenever the blades reach a preset angle (hub switch setting).
When operative it prevents the propeller blades from moving into ground fine pitch should the propeller operating piston override the Flight Fine Lock.
When the hub switch closes, it completes a circuit to the piston valve lift solenoid in the PCU.
Energizing the piston valve lift solenoid will result in oil pressure being directed to the front of the propeller operating piston and the blade pitch angle will coarsen.
As the blade pitch angle coarsens, the cam plate travels clear of the hub switch lever and the spring-loaded hub switch moves away from the sliprings, thus breaking the circuit to the piston valve lift solenoid.
The electro-hydraulic stop sequence of operations will recommence as the propeller fines off again until either:

Engine rpm or airspeed is increased

or

The propeller is feathered

21.4 Piston Valve Lift Solenoid

The piston valve lift solenoid of the PCU is energized by completion of the electro-hydraulic stop circuit and on completion of the auto-feathering circuit. When this solenoid is energized, oil pressure is directed to hydraulically raise the PCU piston valve to the "overspeed" position and oil pressure is directed to the front of the propeller operating piston.
The propeller blades will therefore move to a coarser pitch, while the piston valve lift solenoid is energized and oil pressure is available.

21.5 Manual Feathering

Manual feathering is accomplished by moving the HP cock lever back beyond the SHUT position to the FEATHER position.
This action will lift the piston valve in the controller unit to the "overspeed" position due to the interconnection between the HP cock lever and the feathering selector rod on the PCU.
The solenoid isolating valve in the PCU will also be raised by this action, to shut off the oil pressure supply to the flight fine lock removal solenoid. Lifting the piston valve will result in oil pressure being directed into the increase pitch oil line.
To complete the feathering operation, the feathering unit is brought into operation by pushing in the feathering button on the glare-shield panel.
The feathering button is automatically held in by the action of a hold-in solenoid.
When the propeller operating piston reaches the feathered position, pressure in front of this piston is built up until the pressure cut-out switch is opened.
Opening of this switch will release the feathering switch and stop the operation of the feathering unit.
With the HP cock lever in the FEATHER position the piston valve lift solenoid is energized via the microswitches "A" and "B". The piston valve will now be electro-hydraulically lifted, to "back up" a mechanical operation failure, for instance a control rod disruption.

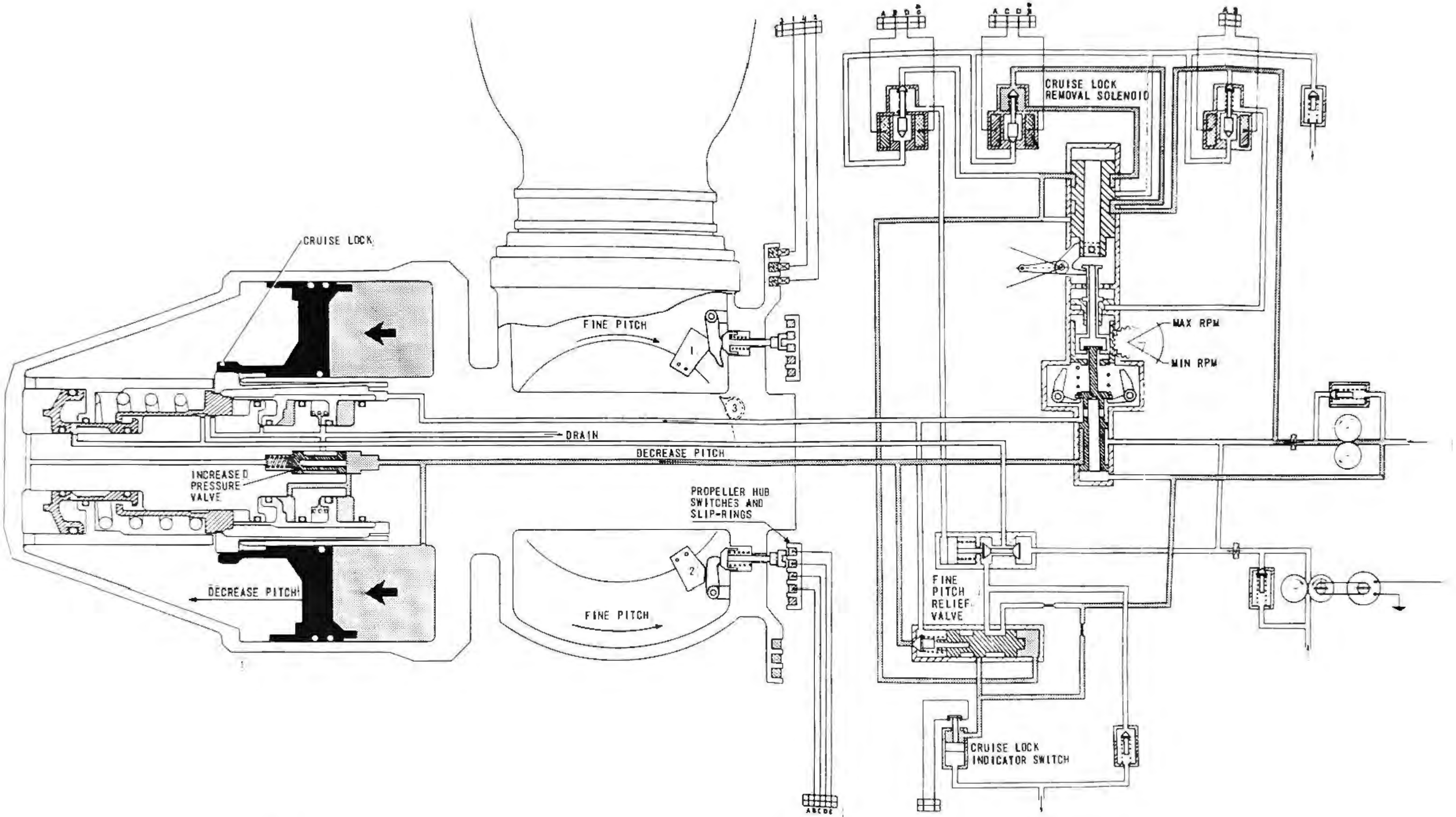
Note: This "back-up" system is standard for A/C. S/N. 10461 and up,
or when "Service Bulletin" 61-26 has been carried out.

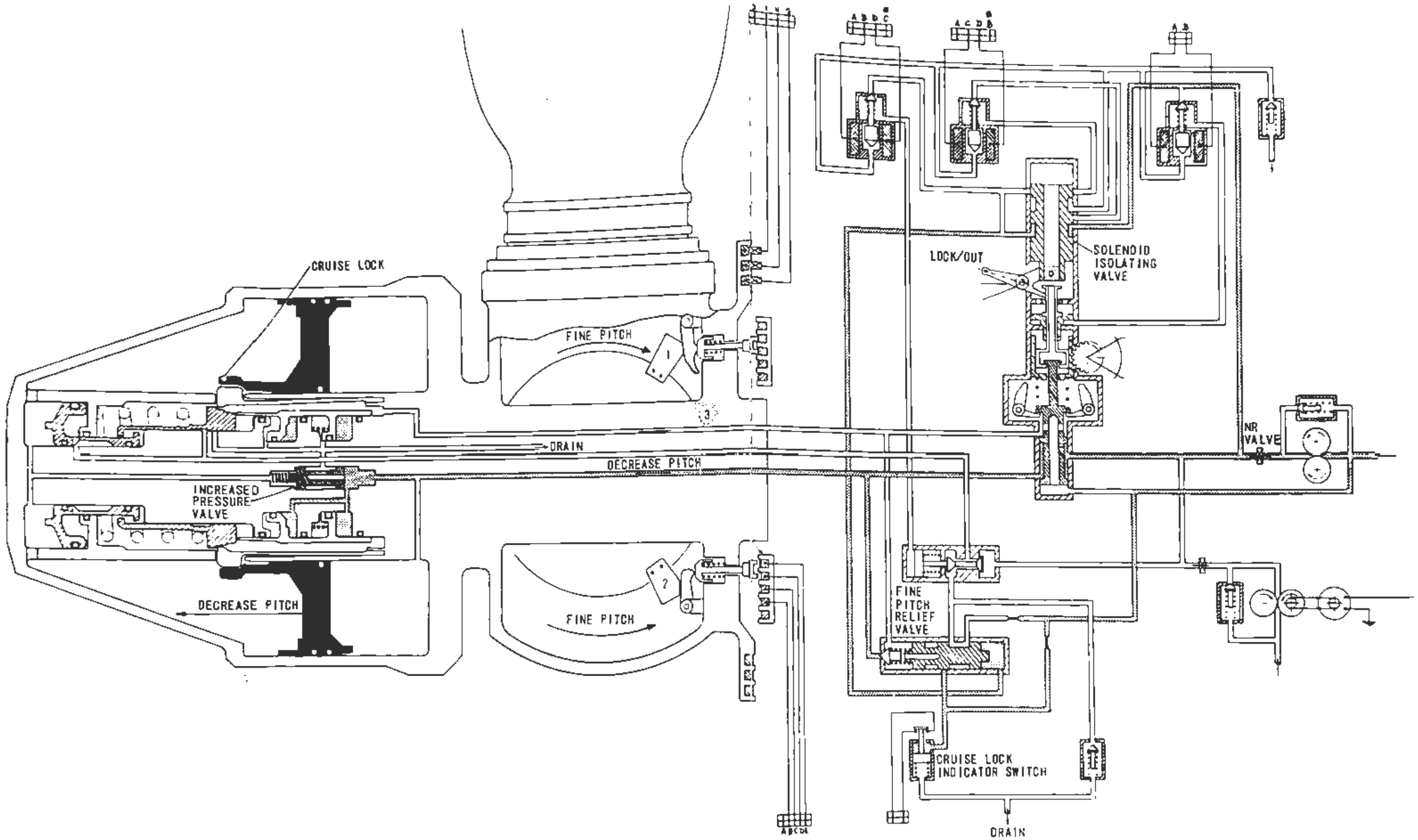
21.6 Auto-Feathering

Automatic feathering will occur in the event of engine failure during take-off and flight, if the power lever is above the 12,800 rpm position and the torque pressure falls to 50 psi or less.

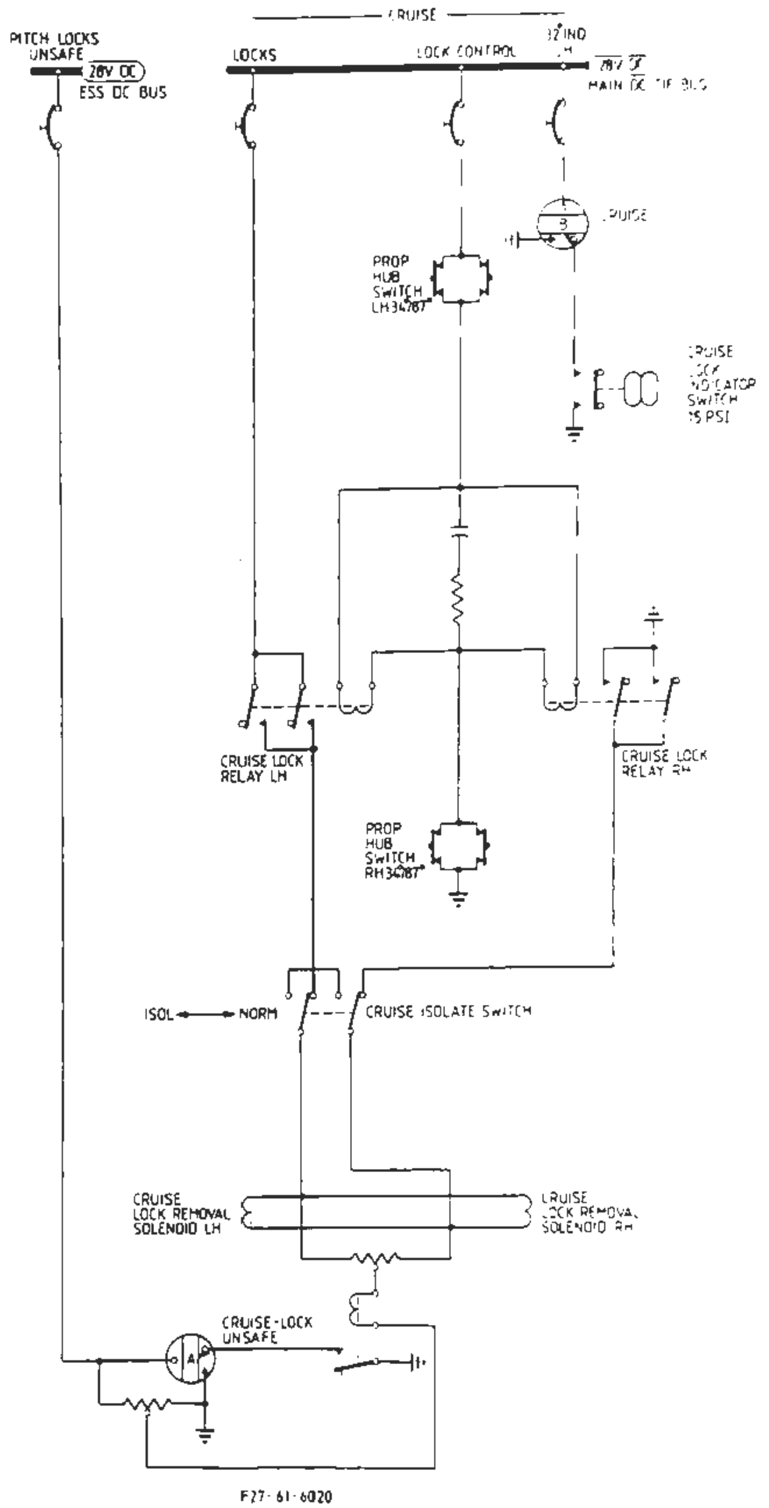
The engine low torque pressure switch will then close and complete the auto-feathering circuit.
When the circuit is completed it brings the feathering unit into operation and energizes the piston valve lift solenoid.
This will hydraulically raise the piston valve of the controller unit to the "overspeed" position to direct oil pressure from the feathering unit to the front of the propeller operating piston.
When the propeller reaches the feathered position, the auto-feathering operation is stopped by moving the HP cock lever to the FEATHER position.
Movement of the HP cock lever to the FEATHER position will open the auto-feathering circuit and simultaneously secure the piston valve of the controller unit in the "overspeed" position in order to keep the propeller feathered and to operate the solenoid isolating valve.

END

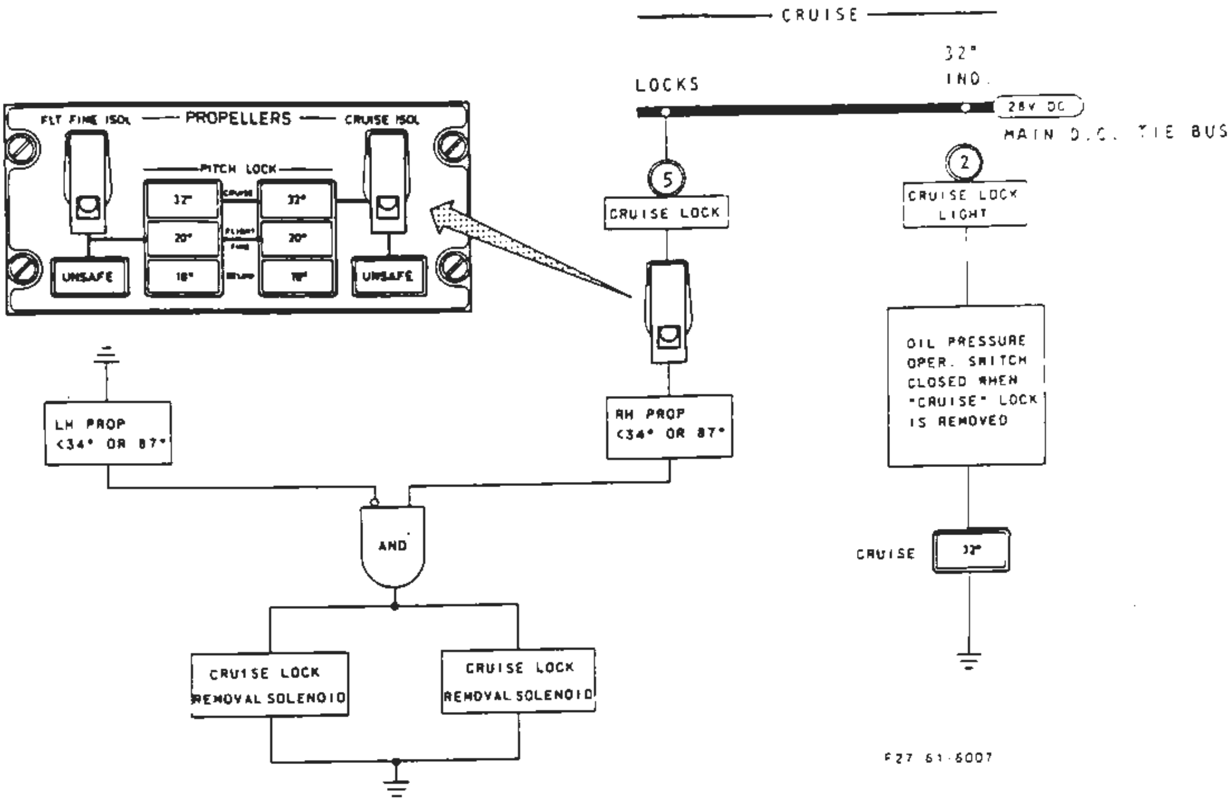

CRUISE LOCK
CRUISE LOCK
REMOVAL SOLENOID
FINE PITCH
MAX RPM
MIN RPM
DRAIN
DECREASE PITCH
INCREASED
PRESSURE
VALVE
PROPELLER HUB
SWITCHES AND
SLIP-RINGS
DECREASE PITCH
FINE PITCH
FINE
PITCH
RELIEF
VALVE
CRUISE LOCK
INDICATOR SWITCH



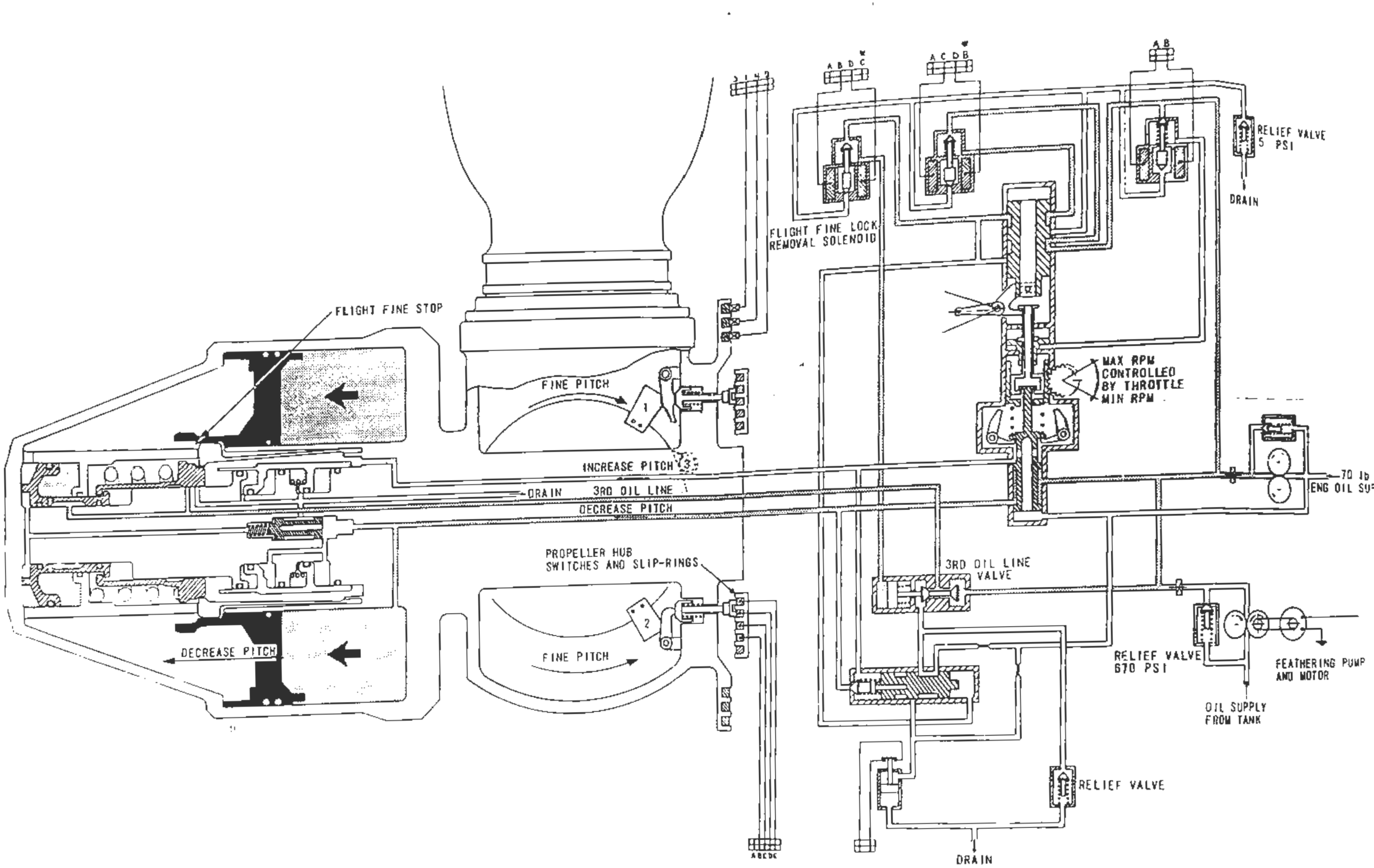
CRUISE LOCK MANUAL REMOVAL



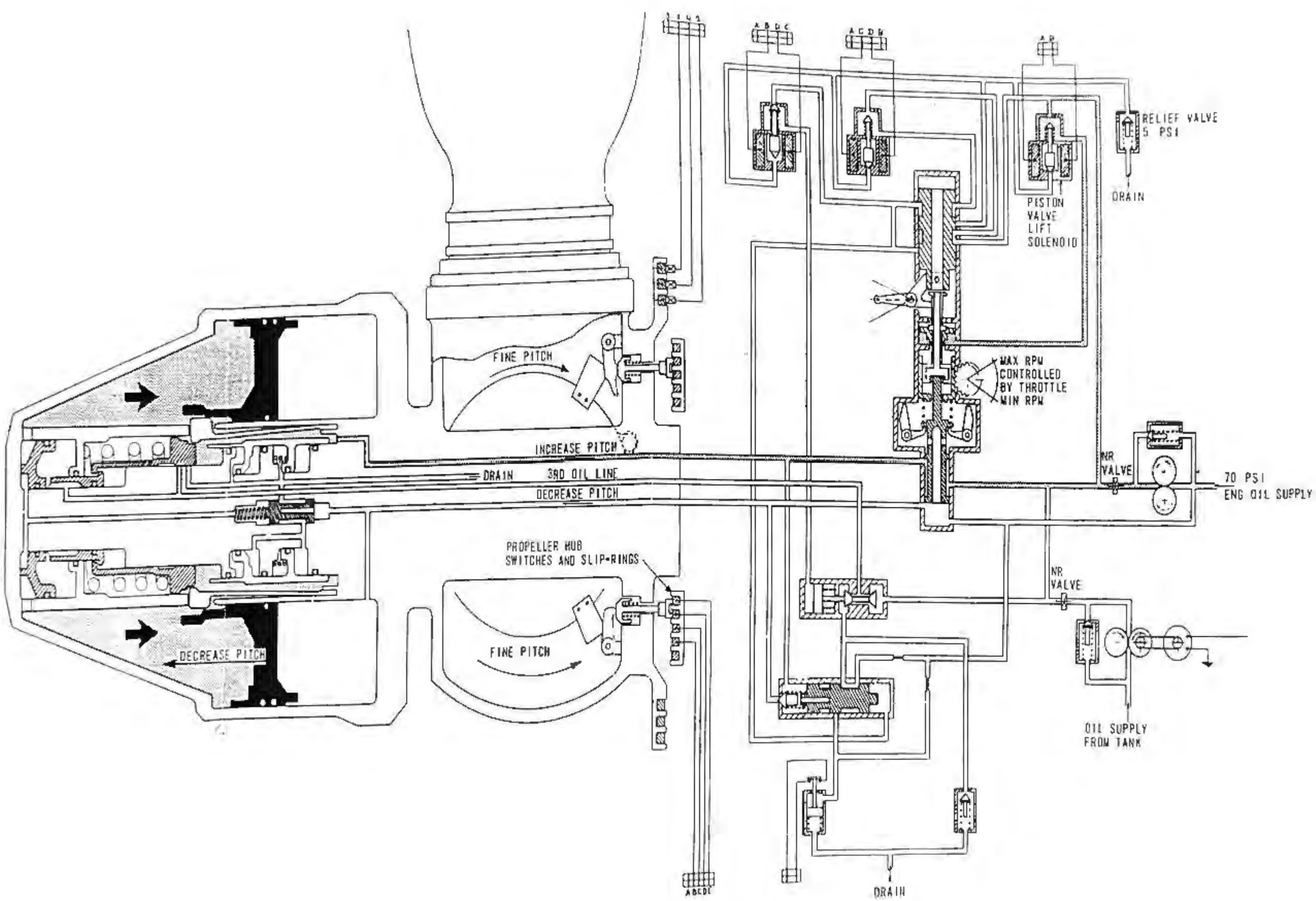
AUTOMATIC "CRUISE LOCK" OPERATION



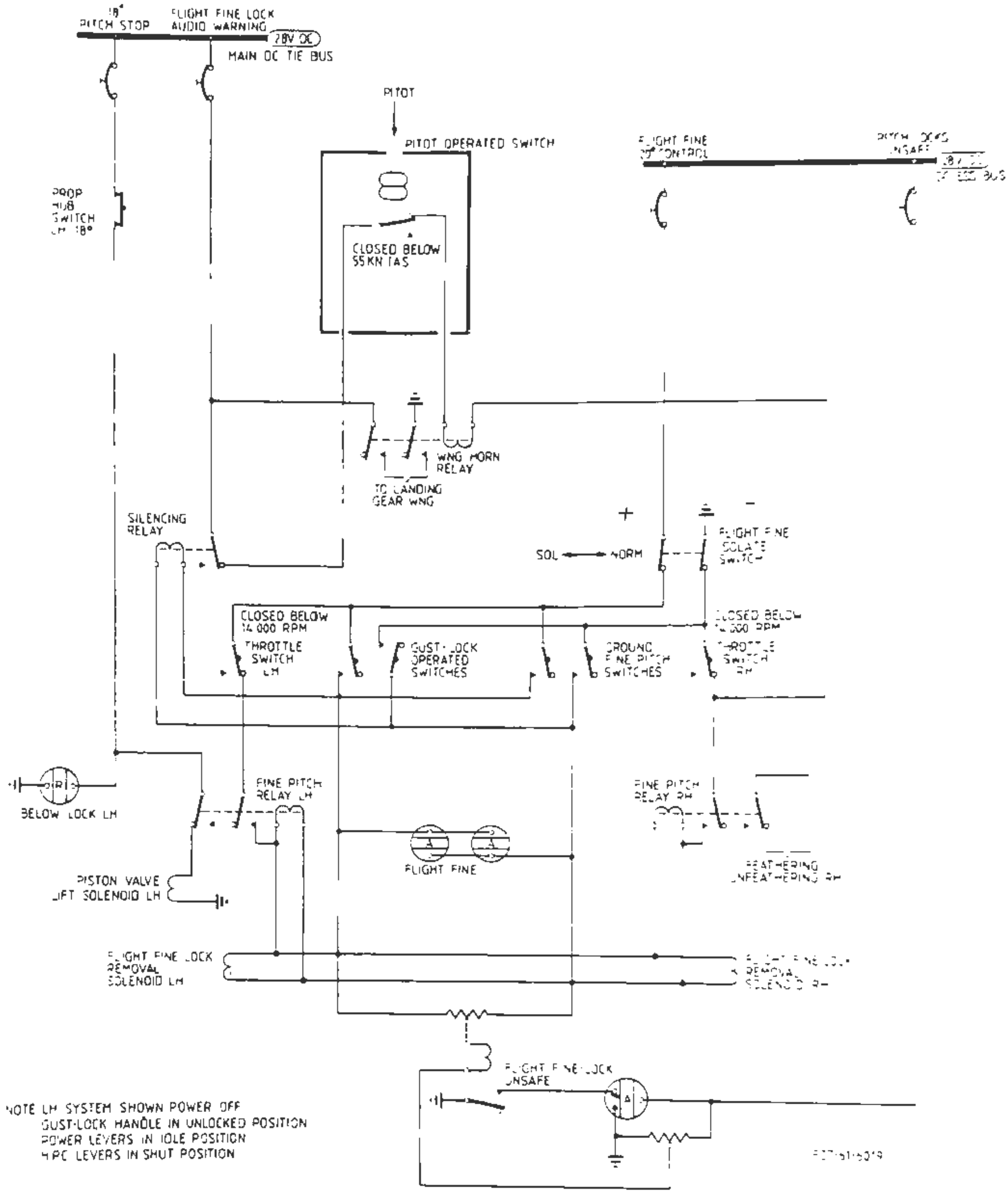
AUTOMATIC "CRUISE LOCK" OPERATION



FLIGHT FINE LOCK REMOVAL

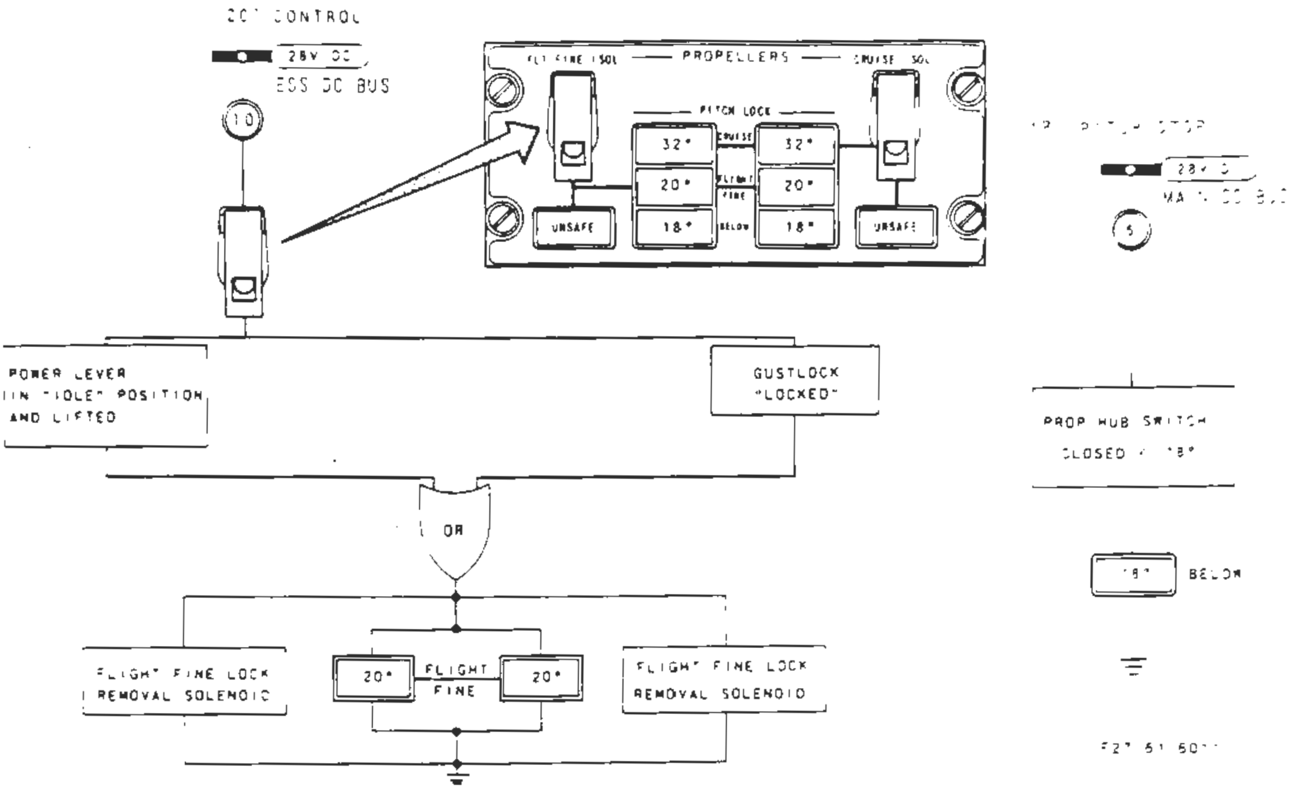


ELECTRO-HYDRAULIC PITCH STOP

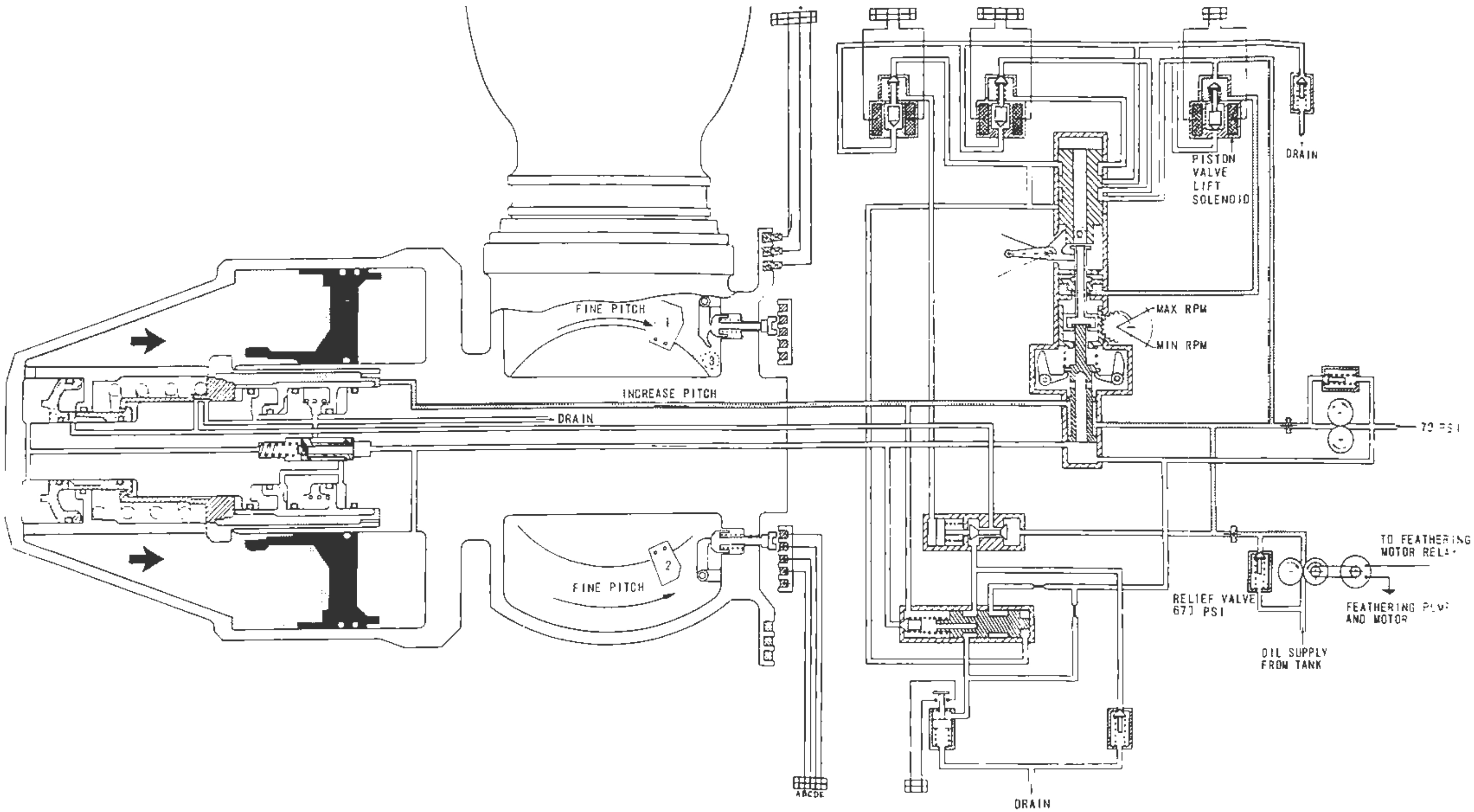


SELECTION OF "GROUND FINE" AND ELECTRO/HYDRAULIC STOP OPERATION

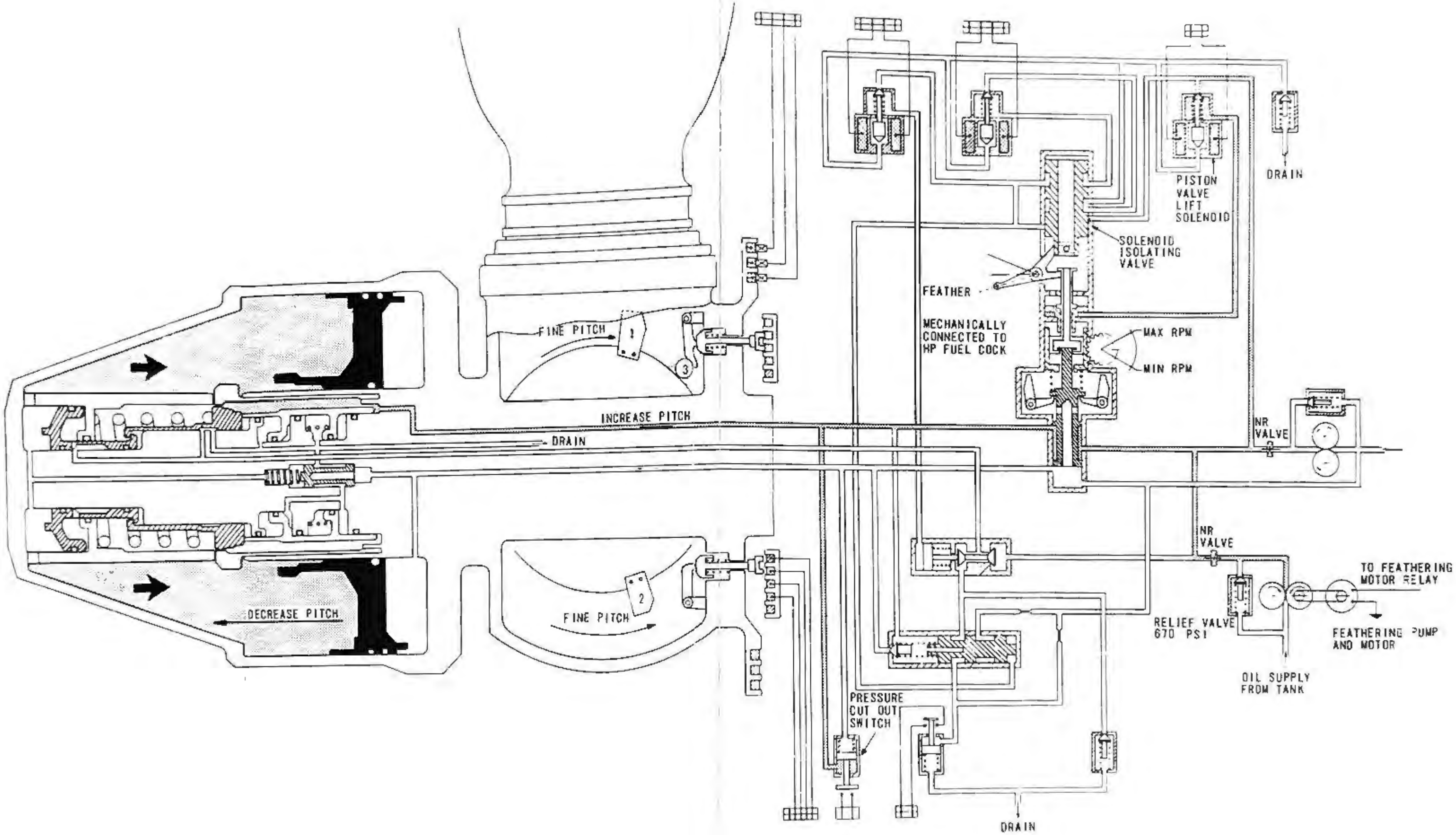
ON GROUND ONLY



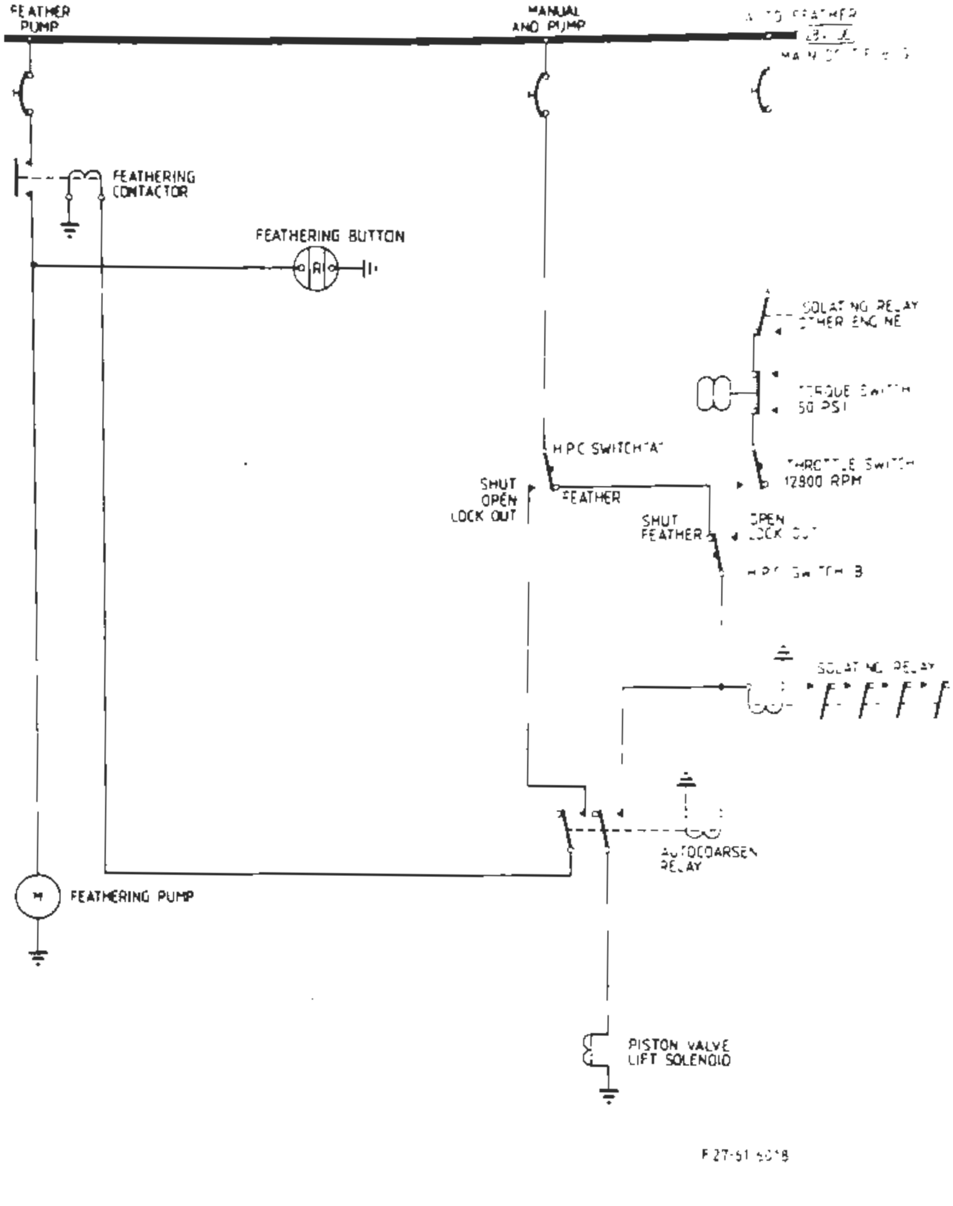
SELECTION OF "GROUND FINE"



AUTOMATIC FEATHERING



MANUAL FEATHERING



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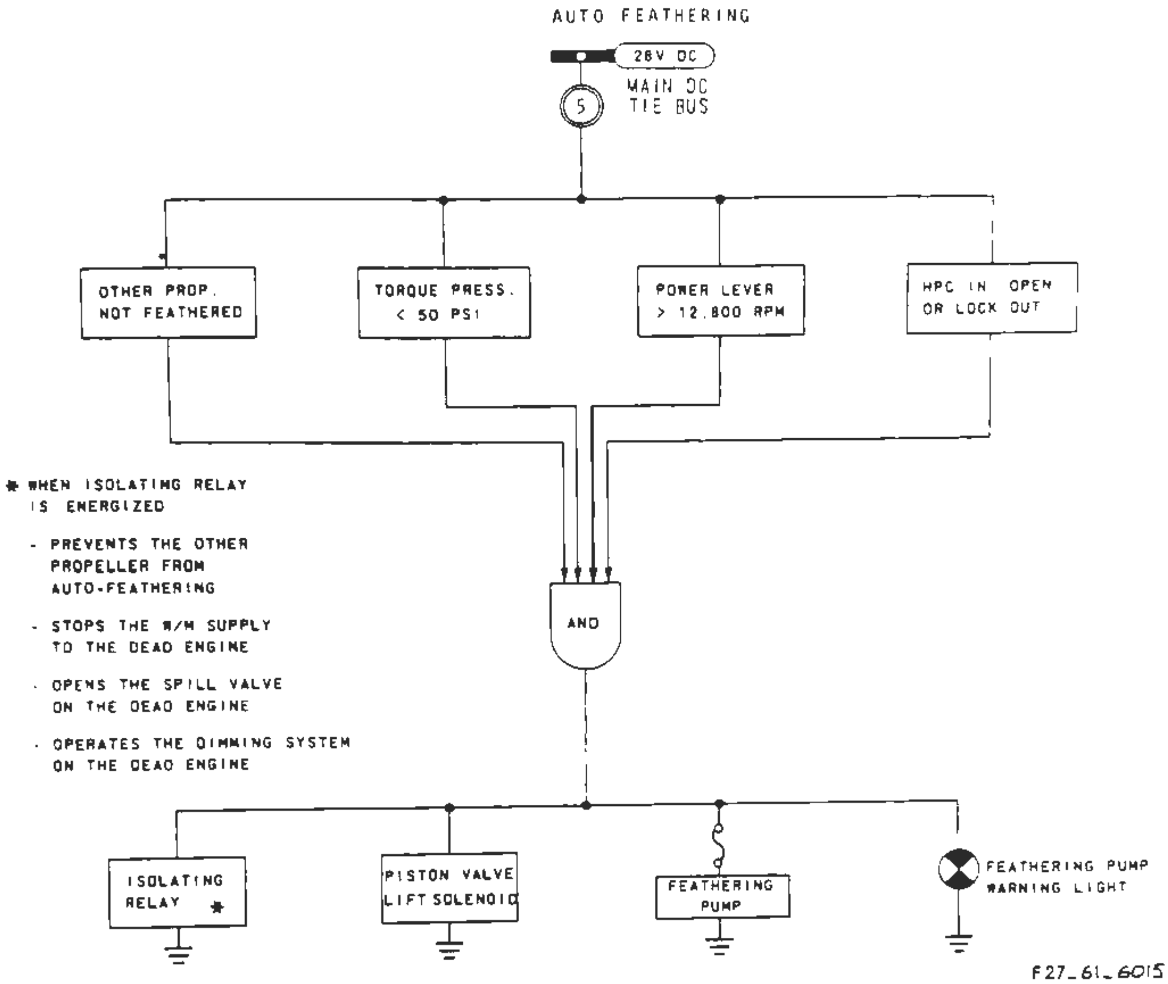

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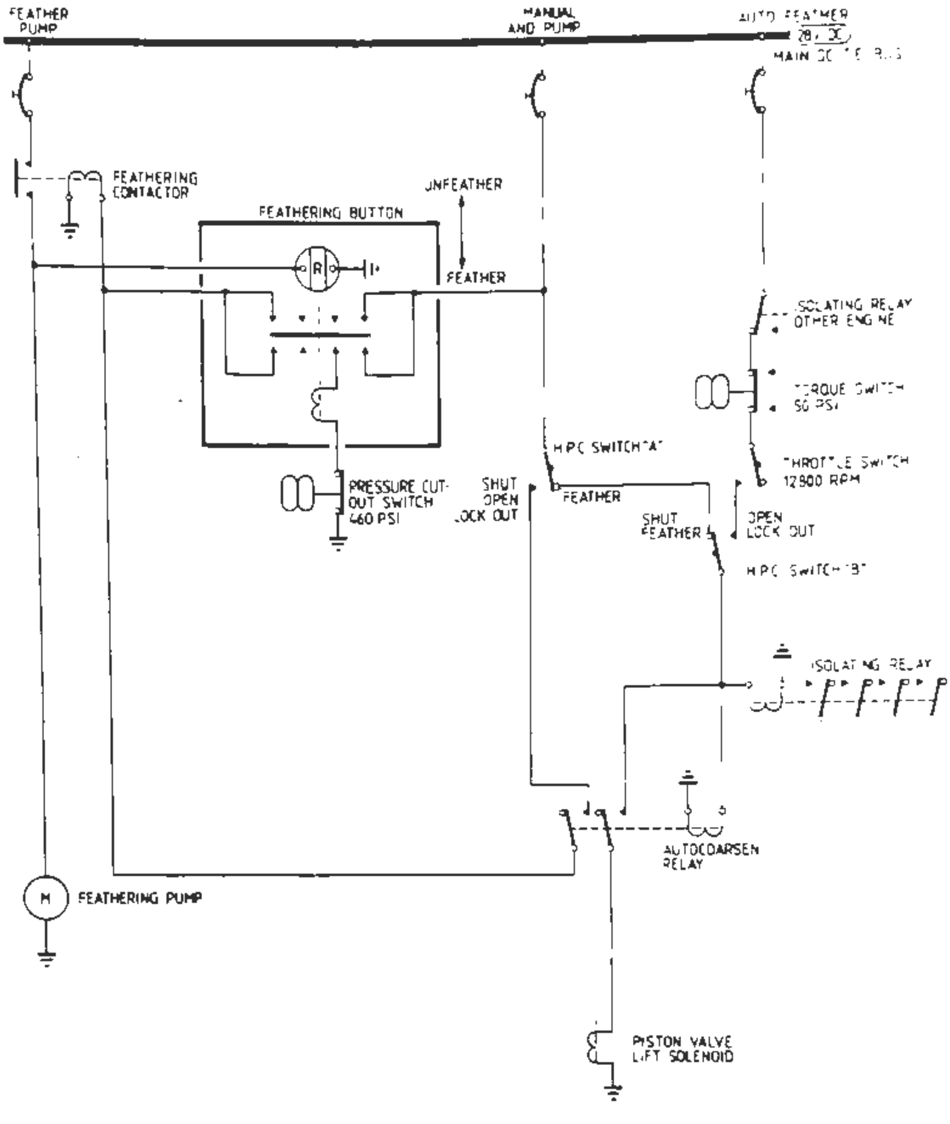
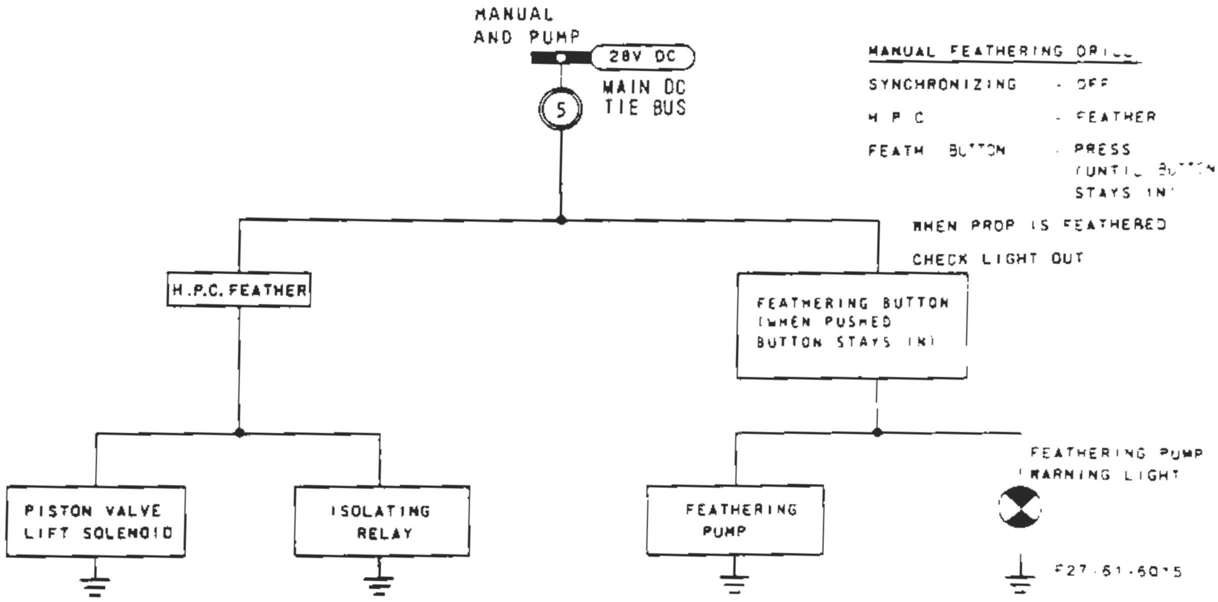


MANUAL FEATHERING



MANUAL FEATHERING

40.0 INDICATING

To provide the ground and flight crew a visual indication the following propeller lights are installed on the main instrument panel.

40.1 Flight Fine Lock Lights

The amber lights will illuminate when the flight fine lock removal circuit is energized.

40.2 Below Lock Lights

The red lights will illuminate when the respective hub switch is closed and the auto-coarsen relay is inoperative.

40.3 Cruise Lock Lights

The blue lights will illuminate when the respective pressure switch on the propeller unit is closed (cruise lock unlatched).

40.4 Flight Fine Lock Unsafe Light

The amber light will illuminate when the flight fine lock removal circuit becomes unsafe.

40.5 Cruise Lock Unsafe Light

The amber light will illuminate when the cruise lock removal circuit becomes unsafe.

Feathering pump operative

The red warning lamps are installed in the feathering switches. They illuminate when the respective feathering pump is activated.

END

40.0 INDICATING

To provide the ground and flight crew a visual indication the following propeller lights are installed on the main instrument panel.

40.1 Flight Fine Lock Lights

The amber lights will illuminate when the flight fine lock removal circuit is energized.

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The amber light will illuminate when the flight fine lock removal circuit becomes unsafe.

40.5 Cruise Lock Unsafe Light

The amber light will illuminate when the cruise lock removal circuit becomes unsafe.

Feathering pump operative

The red warning lamps are installed in the feathering switches. They illuminate when the respective feathering pump is activated.

END

50.0 MAINTENANCE NOTES PROPELLER SYSTEM

Since correct functioning of the propeller is essential, the following tests must be carried out before ground running of the engine after a propeller change, whenever any unit in the propeller control system has been replaced or otherwise disturbed and at prescribed intervals. Provided that the propeller system warning and/or indication lights are proved initially, they may conveniently be used as guides to propeller pitch changes during the tests.

NOTE: During certain manipulations with the HPC levers, the spill valve lights may illuminate or extinguish which is to be considered as attendant circumstances.

Testing of only a part of the propeller system is permissible if the other parts have not been affected during maintenance or replacement procedures.
For this purpose the test procedure is divided into sections; each of them may be carried out independent of other sections provided the preparation and preliminary checks have been performed.
The feathering unit should not be operated longer than necessary for confirming the check but should never be operated more than 3 minutes in any hour in order to provide a sufficient cooling period for the feathering unit motor.

CAUTION: DO NOT CONTINUE TO OPERATE THE FEATHERING UNIT LONGER THAN ESSENTIAL FOR CONFIRMING THE CHECK ESPECIALLY WHEN THE PROPELLER IS NOT FREE TO CHANGE PITCH.

During static feathering or unfeathering of the propeller, displaced oil from the propeller pitch change mechanism is discharged into the main oil pressure lines of the engine. With the engine static this oil is not scavenged from the region of the main assembly oil seals nor will draining of the sump clear it. To avoid flooding of the engine special Rolls Royce equipment, coded HW68267, is available. It consists of a special oil filter casing end cap and a flexible hose. When fitted to the oil filter casing, displaced oil from the propeller pitch change mechanism is circulated directly back into the engine oil tank through the flexible hose, thus preventing this oil from being discharged into the main pressure oil lines of the engine.

50.1 Electro-Hydraulic Stop

The electro-hydraulic stop function test can be carried out as follows:

. Power levers	-	IDLE
. HPC levers	-	SHUT
. Gustlock handle	-	locked
. Isolating switch	-	isolate
. Flight Fine lock lights	-	OUT
. LH feathering button	-	pull out LH prop should coarsen off
. Below lock light	-	alternately on and off

repeat check for RH propeller.

50.2 Flight Fine Lock

The Flight Fine lock function test can be carried out as follows:

. Propeller blade angle	-	both above 20°
. Power levers	-	T/O

. HPC levers - SHUT
. Gustlock handle - UNLOCKED
. Isolating switch - NORMAL
. LH feathering button - pull out and release when check is confirmed
. LH prop fines off until the flight fine lock is reached
. Gustlock handle - LOCKED
. LH feathering button - pull out and release when check is confirmed
. LH prop breaks through the Flight Fine lock
repeat check for RH propeller.

50.3 Cruise Lock

The cruise lock function test can be carried out as follows:

Check 1

. Propeller blade angle: fully feathered
. LH HPC lever - OPEN
. LH feathering button - pull out, and release when check is confirmed

LH propeller fines off and breaks through the cruise lock
repeat check for RH propeller.

Check 2

. Propeller blade angle - both above 34°
. LH HPC lever - OPEN
. LH feathering button - pull out, and release when check is confirmed.

LH propeller fines off until held at the cruise lock

. LH HPC lever - LOCK-OUT
. LH feathering button - pull out, and release when check is confirmed.

LH propeller fines off and breaks through the cruise lock
repeat check for RH propeller

50.4 Auto-feather Check (LH engine)

. Gustlock handle - LOCKED
. DC power switch - EXT. POWER or BATT.
. Flight fine lock light - On
. Cruise lock light - Out
. Prop. below lock lights - On
. HPC lever of RH engine - FEATHER
. HPC lever of LH engine - OPEN
. Power lever of LH engine - Max. power, LH propeller should not feather.
. HPC lever of RH engine - SHUT, LH propeller should start feathering (LH prop-below-lock light out)

As soon as auto-feathering of LH propeller is apparent:

. HPC lever of LH engine - SHUT, check (feathering pump warning light out), prop-below-lock lights and flight-fine-unlocked lights on).

- Power lever of LH engine - IDLE
- HPC lever of LH engine - LOCK-OUT
- Feathering button LH engine - Pull until propeller is in GFP (marks on blades and spinner aligned)
- HPC lever of LH engine - SHUT

NOTE: If the propeller is permitted to feather completely, a motoring procedure must be performed at conclusion of the check in order to return the feathering oil to the tank.

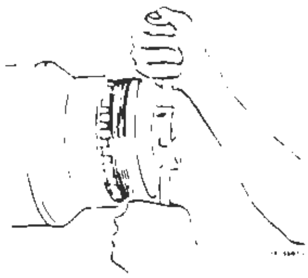
Repeat procedure for RH engine.

50.5 Air-speed Switch

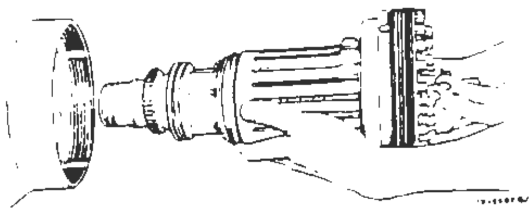
Functional test

- Connect a pitot-static system leak tester to the LH pitot tube
- Gustlock handle - UNLOCKED
- LH power lever - fully forward, warning horn sounds
- Apply a pressure of at least 55 knots the warning horn ceases.
- Disconnect leak tester
- Gustlock handle - LOCKED

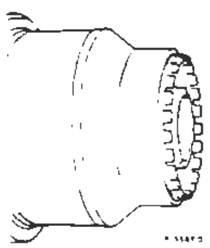
END



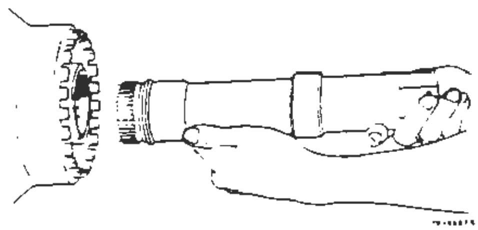
UNSCREWING THE CYLINDER NUT



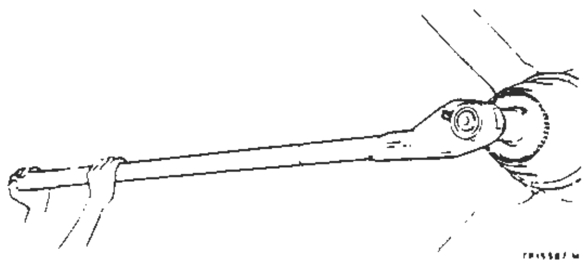
WITHDRAWING THE PITCH LOCK ASSEMBLY



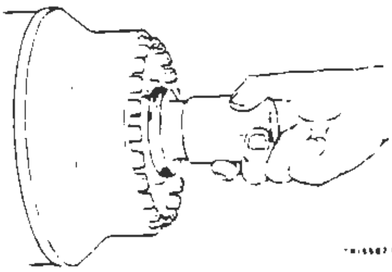
CYLINDER NUT SPANNER FITTED AS GUIDE FOR HUB NUT SPANNER



INSERTING HUB NUT SPANNER

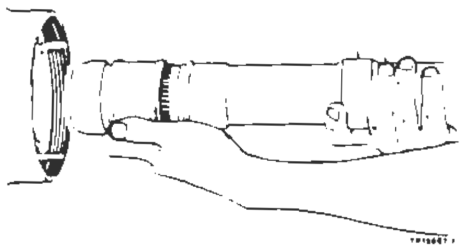


LOOSENING HUB NUT WITH TORQUE SPANNER

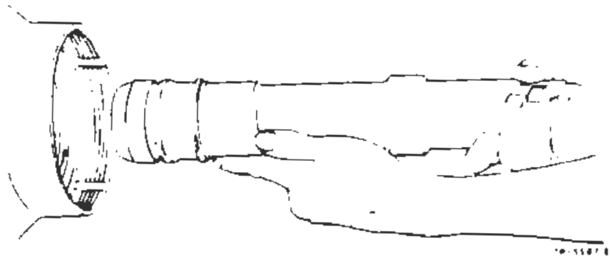


SCREWING EXTRACTOR INTO GUIDE

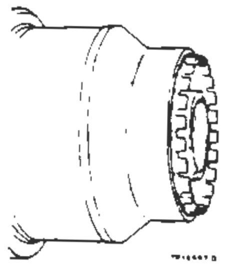
REMOVING THE PROPELLER



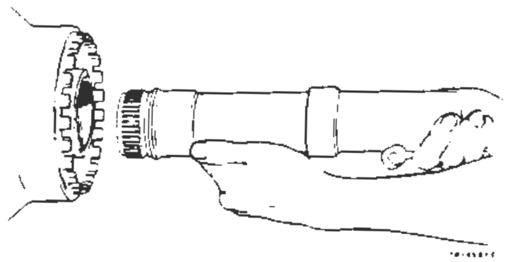
FITTING HUB NUT AND CONE ASSEMBLY
TO HUB NUT SPANNER



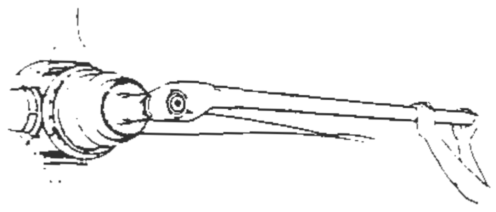
FITTING HUB NUT AND CONE ASSEMBLY
TO THE SHAFT



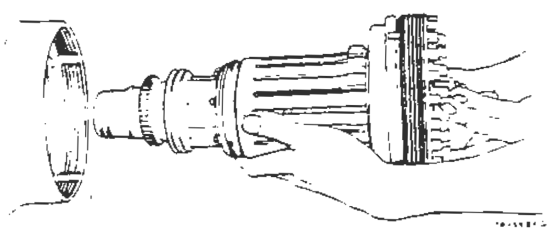
CYLINDER NUT SPANNER FITTED AS
GUIDE FOR HUB NUT SPANNER



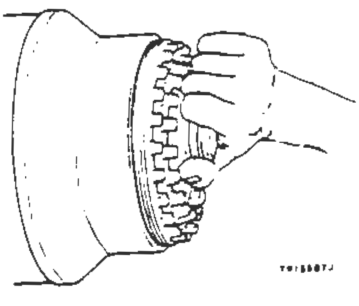
INSERTING THE HUB NUT SPANNER



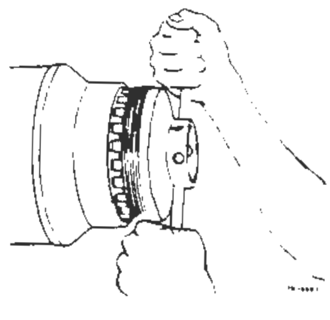
TIGHTENING HUB NUT WITH TORQUE
SPANNER



INSERTING THE PITCH LOCK ASSEMBLY



CHECKING SERRATION ENGAGEMENT



TIGHTENING THE [illegible]NDER NUT

INSTALLING THE PROPELLER

71

POWER PLANT

71. POWER PLANT

10.0 POWER PLANT COWLING

Each power plant is enclosed by four removable cowling panels.

The top cowling panel, which is normally not opened for minor maintenance and servicing, is locked to the firewall by 5 screws and to the front air intake cowling with 2 Napier lock screws.

In the top cowling panel are incorporated the oil cooler outlet, compressor cooling air inlet, gearbox drive-shaft cooling air intake, universal joint access door, and an oil filler cap and dipstick access door.

The side panels are hinged to the top cowling panel by spring-loaded hinge pins which can be withdrawn to allow complete removal of the side cowlings. The side panels are attached to the lower cowling panel by a Napier lockscrew and 3 King toggle fasteners on each panel.

The bottom cowling panel is hinged to the fire-wall and is locked to the front air intake cowling by means of 2 Napier lock screws.

Cooling and ventilation air inlet and exhaust apertures are provided in the cowlings, and also access doors for fire fighting purposes.

The gearbox compartment is covered by a hinged panel, the trailing edge of which forms a cooling and ventilating air outlet over the top surface of the mainplane.

Incorporated in this panel is a wing-ice inspection light.

When opened, the bottom cowling, the two side cowlings and the gearbox compartment panel are held open by "over-centre" locking support struts.

11.0 ACCESSORY GEARBOX AND DRIVES

Accessory Gearbox.

A Rotol engine-driven accessory gearbox is mounted in each nacelle gearbox compartment.

The following components are driven from the gearbox:

Component	Drive Ratio (to engine rpm)
Pneumatic Compressor	0.232
Cabin Blower	0.535
DC Generator	0.417
Alternator	0.672
Tachometer Generator	0.250
Synchroniser Alternator	0.378

The gearbox consists of a magnesium alloy casing with quill drives to each accessory.

Two side trunnions provided with "metalastik" mountings and a front bracket attach the gearbox to the nacelle structure.

The left-hand side trunnion is provided with a distance piece for lateral adjustment.

The lubrication system is self-contained in the gearbox and includes an oil pump and a valve which acts as a relief valve and also controls the oil to the cabin blower, pneumatic compressor and the extension drive shaft support.

A breather is fitted which also dispels any leakage of air from the cabin blower into the gearbox.

Accessory Gearbox Oil Pressure Warning Light.

Two "PRESS-TO-TEST" warning lights are provided on the main instrument panel. Should a gearbox oil pressure fall below 25 + 5 psi the relevant warning light on the main instrument panel will be illuminated.
The light is operated by a pressure switch on the nacelle bulkhead which is connected by an external pipe to the gearbox oil system.

Accessory Gearbox Drive Shaft.

A tubular drive shaft, incorporating a universal joint at each end, is installed between the engine drive flange and the accessory gearbox and passes through an aperture in the nacelle fire wall.
A two-piece removable metal cover is fitted between the fire wall and the front of the gearbox to provide a flame-tight seal between zones II and IV.
To facilitate removal or installation, the drive shaft can be disassembled into three major assemblies.
These are the splined shaft section which fits into the gearbox assembly, the coupling housing and the universal joint which attaches the shaft to the engine drive flange.

Installing the Accessory Gearbox.

The gearboxes are interchangeable between the left- and right-hand side provided that the following units are changed over:

(1) DC generator and the alternator plus adaptor.

(2) The self-sealing oil drain connection in the base of the sump with a blanking plug on the other side of the sump.

NOTE: The generator is mounted on the outboard side of the gearbox for both installations. The oil drain connection is always on the inboard side.

When an accessory is removed from the gearbox, advantage should be taken to withdraw and examine the quill shaft for general condition. Before refitting the quill shaft, check for an easy slide on the mating accessory shaft, in particular when a new accessory shaft is fitted.

All drive quills are to be immersed in gearbox oil and are to be installed "wet".

Installing the Gearbox Drive Shaft.

When a new assembled drive shaft is received from the store and has to be fitted on the aeroplane the following procedure is recommended:

- Remove the 4 bolts securing the drive shaft to the coupling flange on the engine side.

NOTE: Mark the two flanges to facilitate assembly of the two parts in the same position in order not to disturb the accurate balancing of the complete drive shaft.

- Remove the splined coupling flange from the engine-end universal joint by removing the ring nut, cup washer and bushing.

- Remove flail guard from engine and fit it over the engine-end universal joint and refit coupling flange, smeared with grease on serrated fork joint and install bush, cup washer and ring nut. Torque the ring nut.

NOTE: The coupling flange can only be fitted in one position on the universal joint, due to a master spline.

- Connect engine-end universal joint to engine drive flange and refit flail guard to engine.

- Check oil seal on splined drive end of the drive shaft and insert drive into gearbox after coating the oil seal and splines with gearbox oil.

- Secure the flange of the drive shaft to the coupling flange in the marked position and torque the 4 bolts.

- Lubricate grease nipples on the universal joints until new grease extrudes out of each of the four seals.

CAUTION: PROPER LUBRICATION OF THE GEARBOX DRIVE SHAFT UNIVERSAL JOINTS IS OF THE UTMOST IMPORTANCE TO PREVENT PREMATURE BEARING FAILURE. LUBRICATE AS SPECIFIED IN THE F-27 INSPECTION GUIDE.

Should the new grease fail to extrude from any of the seals, the indication is that the existing grease has hardened. In such a case, the drive shaft is to be removed and the universal joint dismantled. Old traces of grease are to be removed and if the joints are satisfactory upon inspection it may be rebuilt.

Inspection of the Universal Joints.

- Universal joint circlip.

  To safequard against the circlips of the universal joints being incorrectly fitted in their grooves and thus being able to disengage, a check on the gap between the "ears" of the circlip should be carried out. Too small a gap indicates improper seating of the circlip in the groove.

- Wear indication.

  Any perceptible movement between the two halves of the joints, which can be felt by hand, indicates that wear has taken place. When this is evident the assembly must be removed and replaced. On intermediate inspections a slight rotation of bearing cups can be permitted until next overhaul. This movement, however, must not be more than one complete turn and can generally be assessed by the amount of scraping of the pigmented lanolin on the end faces of the bearing cups. Evidence of excessive turning of the cups necessitates dismantling of the drive shaft.

Gearbox Oil Pressure Checks.

- After installation of a gearbox check the oil level and replenish if necessary. All topping-up must be done with the oil to the same specification as that already in the gearbox.

  Gearbox Oil Capacity - 4,375 Imp. pints.

  If it becomes necessary to change from one type of oil to another the gearbox must be drained and blown out with compressed air via the oil filter.

- When a gearbox has been installed, check also that there is a positive feedin of oil from the gearbox to the pneumatic compressor and blower. This can be performed by removing the pneumatic compressor oil filter and disconnecting the oil supply hose at the top of the blower and turning the propeller over by hand until oil flows out of the filler and supply hose.

  Pressure Check, can be carried out by:

- Connecting a special pressure gauge between the relief valve and the sensing line to the pressure switch.

- Start engine and run at idling rpm check gearbox oil pressure warning light "OUT".

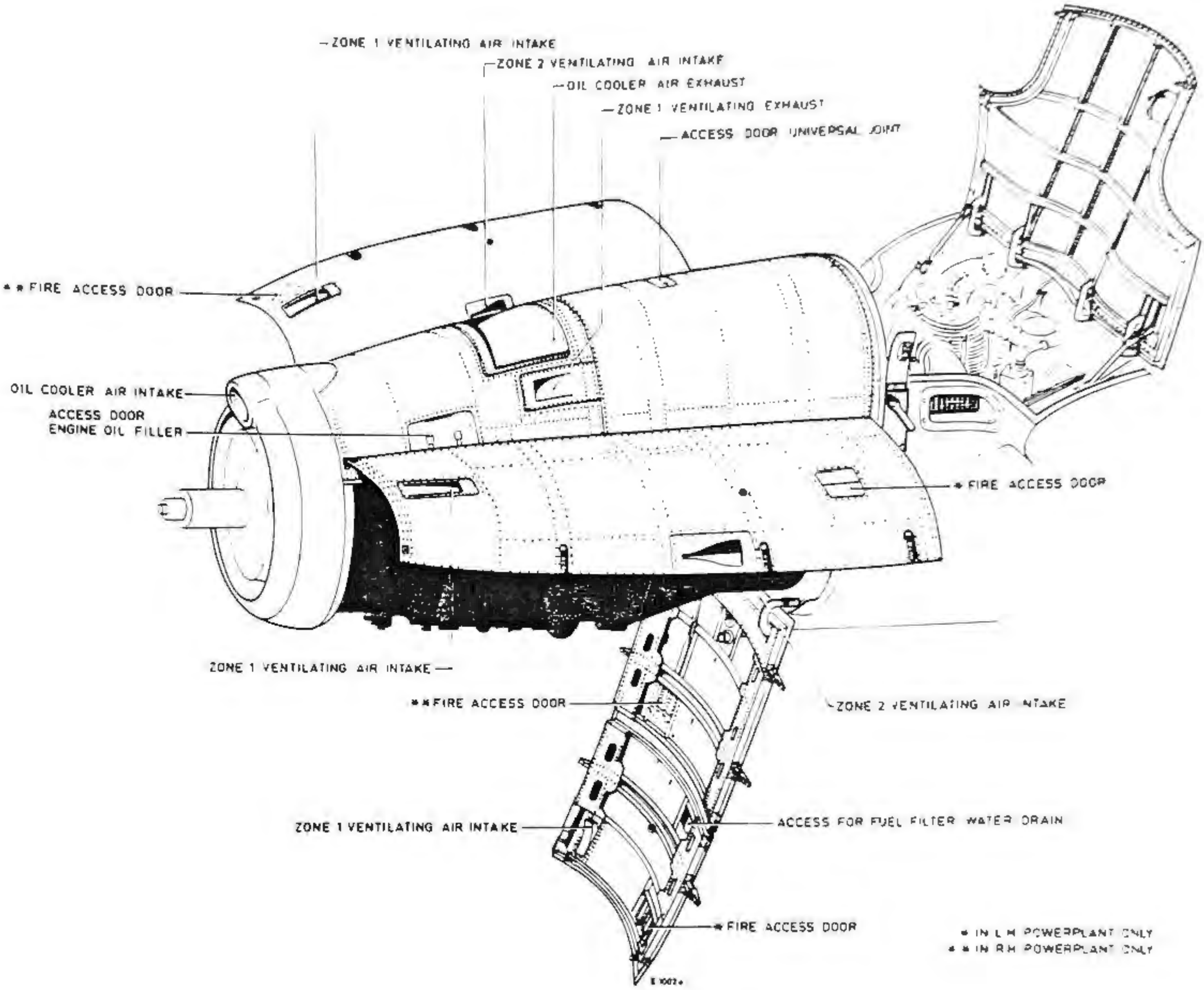
- Run engine at the specified rpm, shut-down engine and check that the dummy pointer on the gauge indicates not less than the minimum required pressure for satisfactory lubrication of the gearbox accessories.

- Inspect oil filter of pneumatic compressor and gearbox.

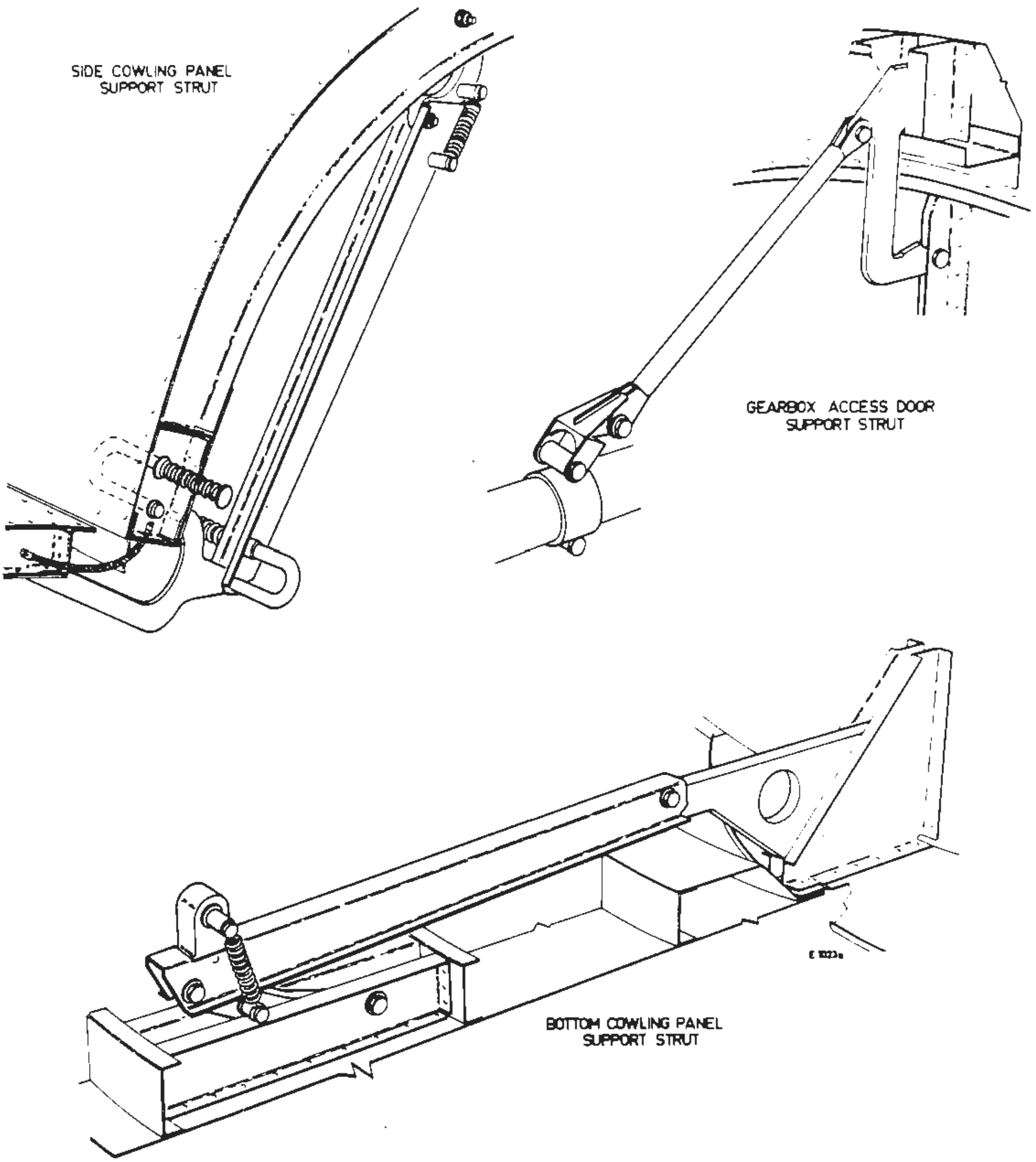
If the oil pressure is less than the minimum required, the gearbox oil system relief valve should be cleaned.

Normally the accessory gearbox low oil pressure warning light will be extinguished when running the engine at idling rpm. If the light remains on, advance the throttle to 8,500 rpm and check that the light is now extinguished.

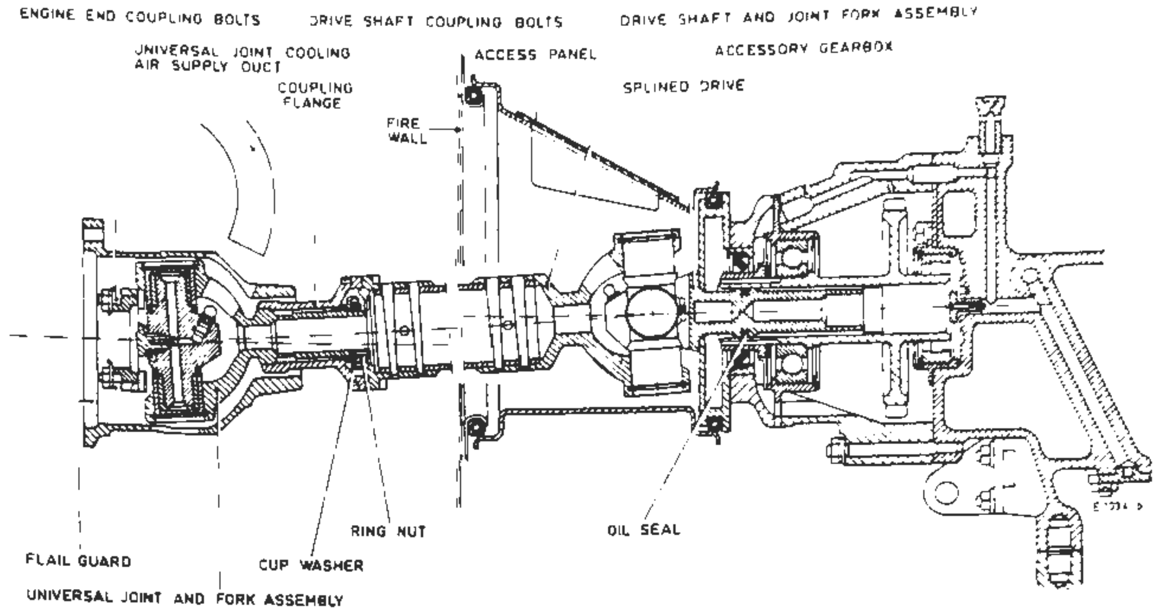
END

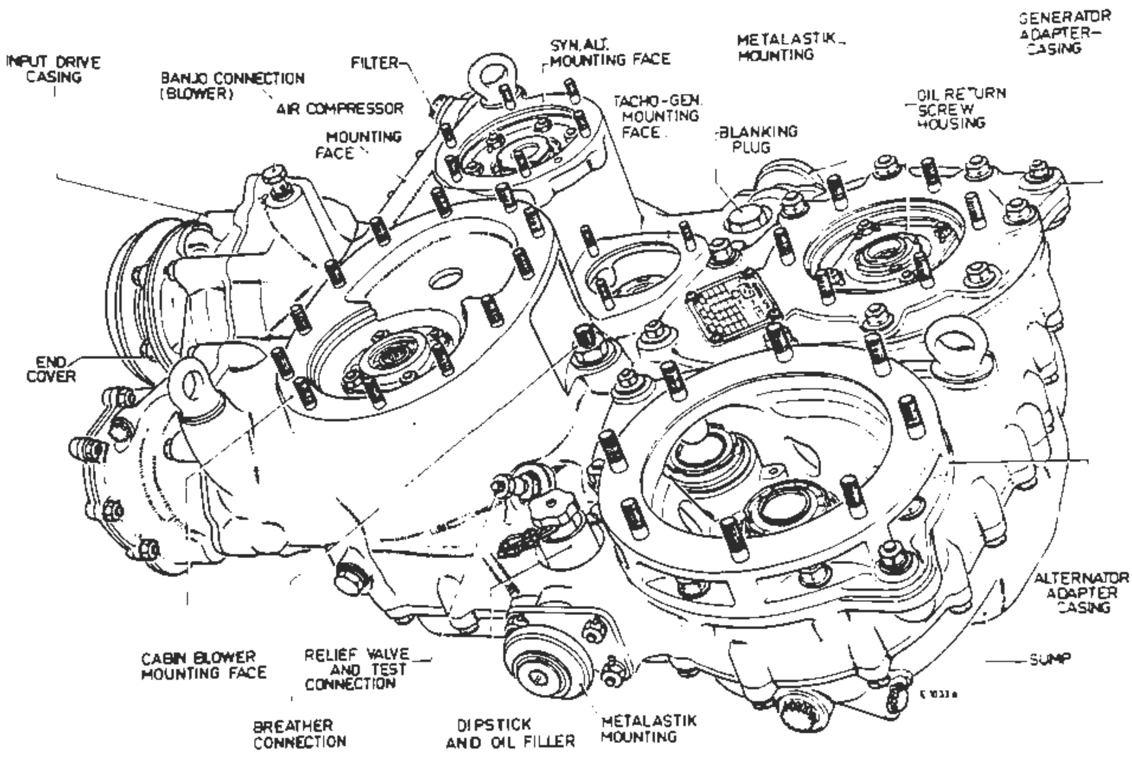


POWERPLANT COWLING

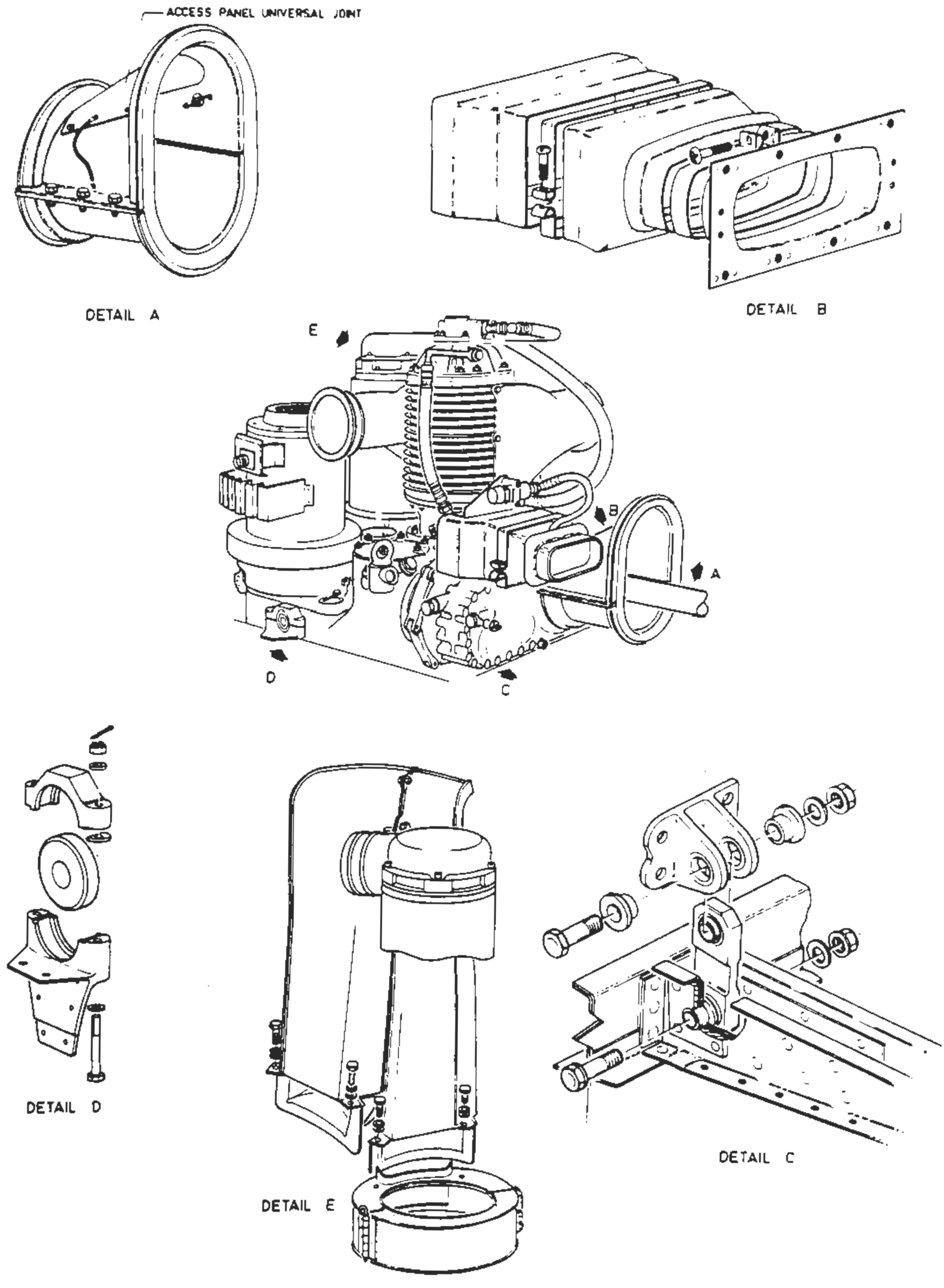


POWER PLANT COWLING SUPPORT STRUTS

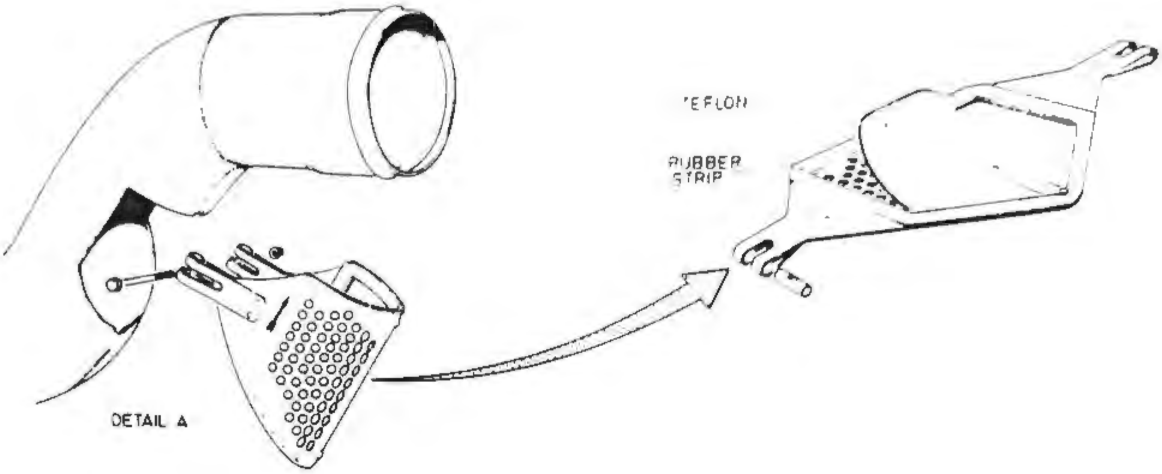


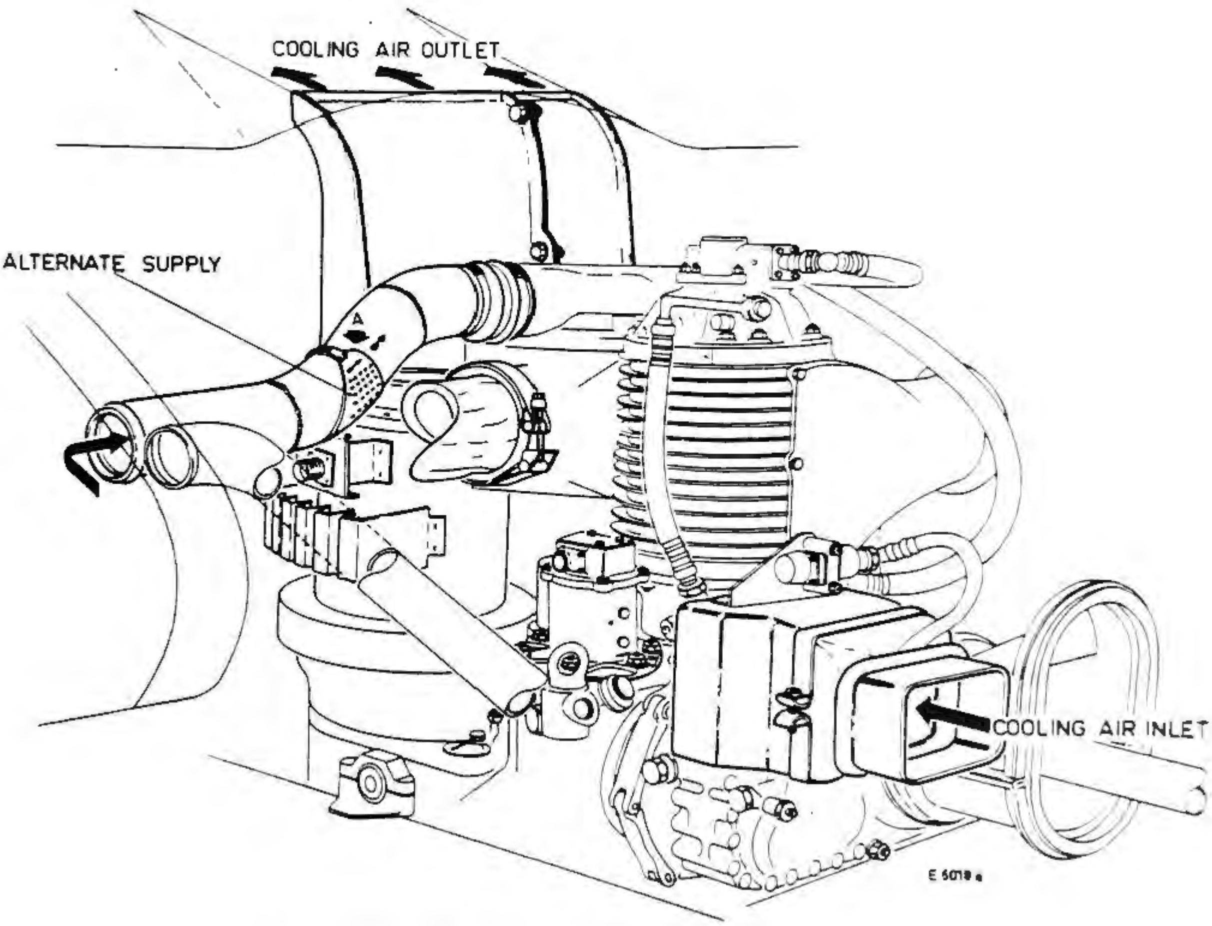


ACCESSORY GEARBOX & GEARBOX DRIVE SHAFT



ACCESSORY GEARBOX INSTALLATION DETAILS





COOLING OF ACCESSORIES ON GEARBOX

20.0 MOUNTS

The engine mounting consists of three "V"-shaped chrome-molybdenum steel tubular members with forged end fittings.

The engine is attached to the mounting by three pick-up points. Two of these are situated on either side, and one on the top of the (aluminium alloy) main compressor casing.

The connection is made by spigot end fittings on the mountings, spherical washers, and hollow attachment bolts, which are in turn locked by LH threaded locking bolts.

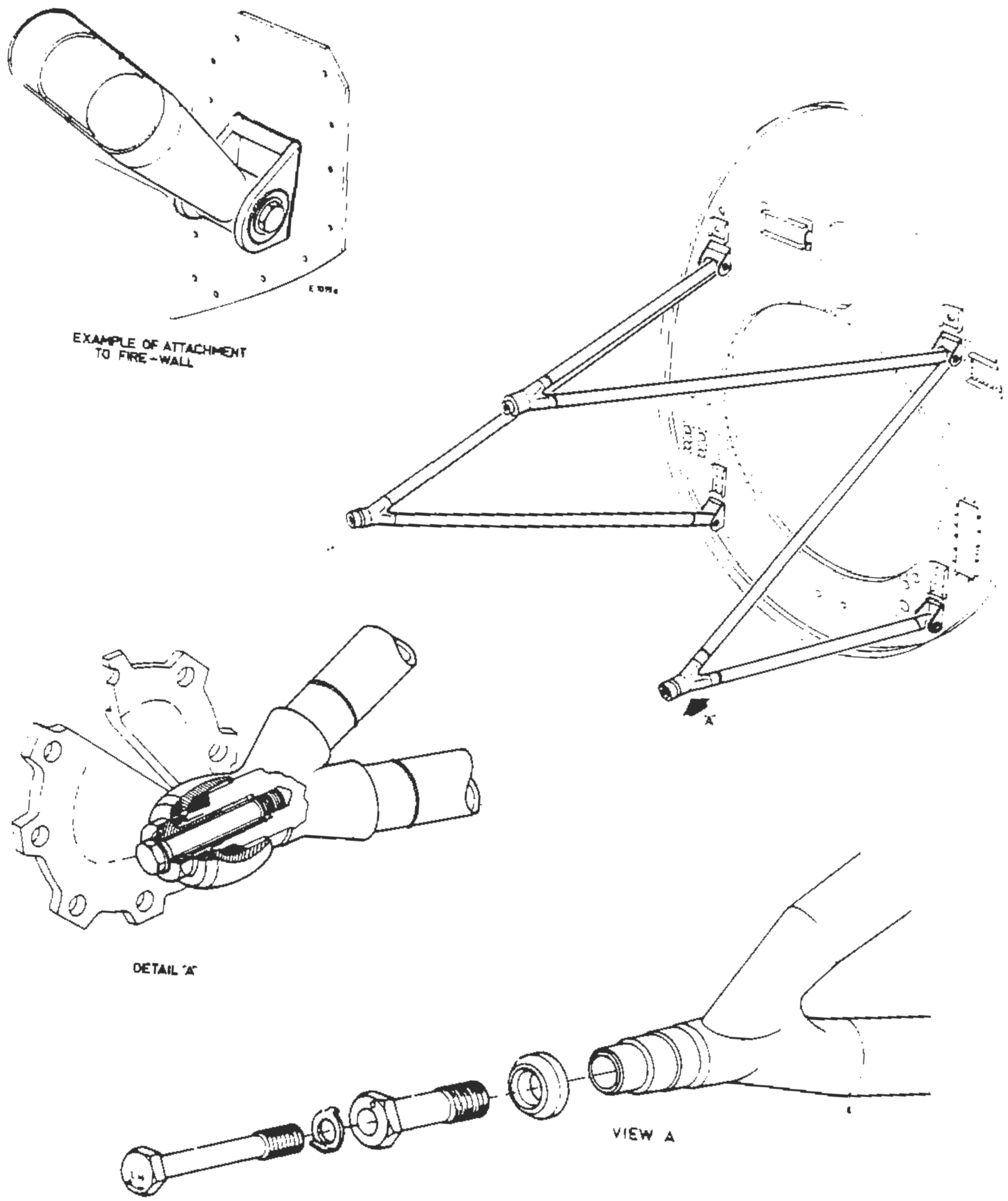
The locking bolts are locked by means of tab washers.

The complete power plant is connected to the four firewall fittings by means of bolts and castle nuts, locked by split-pins.

Mounting bolts torque loading:

Main bolts	)	- refer to Maintenance
Locking bolts (LH thread)	)	Manual.
Fire wall attachment bolts		- ½ inch NAS bolt no specific torque loading.

END



ENGINE MOUNT

72. ENGINE

00.0 GENERAL

The F27 is powered by two Rolls-Royce "DART" engines. For details of these engines and their operation and maintenance, reference should be made to the appropriate Rolls-Royce Manuals.

The brief description of the engine given in the following paragraphs should be regarded as general information, necessary to understand other subjects contained in the Training Manual.

"DART" ENGINE

Propulsion for the F27 aircraft is supplied by two Rolls-Royce "DART" turbo-prop engines which are attached to the nacelle.

Each power plant consists of a turbo-prop engine; a turbular steel engine mounting, a Rotol four-bladed propeller, four readily removable cowling panels and miscellaneous equipment necessary for engine operation.

Principle of Operation

The operating cycle of the turbo-prop engine is a continuous process of taking in air, compressing it in a two stage radial compressor, adding fuel to produce heat in its seven combustion chambers and passing the rapidly expanding gases through a two or three stage turbine. The turbine drives the compressor, the propeller reduction gear and the accessories. Unlike the turbo-jet engines where the turbine only extracts sufficient energy from the gases to drive the compressor and the accessories, the turbine of the "DART" is designed to extract as much energy as possible.

The turbine assembly develops power in the order of 4,600 to 6,600 HP at take-off rpm of which approximately two thirds is taken by the compressors.

The remainder, after subtraction of the power to drive the engine components and auxiliaries, is the Shaft Horse Power (SHP) for driving the propeller.

However, some useful energy remains in the exhaust, which produces a certain amount of thrust by reaction.

Structural Units

The main structural units are:

- Air intake casing
- Compressor casing
- Engine intermediate casing
- Combustion chambers
- Nozzle box
- Exhaust unit

The air intake casing contains an annular duct which directs the air to the compressor, an integral oil tank and the propeller reduction gear. On the forward side of the air intake casing is attached a nose cowling which is electrically de-iced. Located on the left-hand side of the air intake casing is the oil filler cap, the main accessories installed on this side are the water/methanol unit, FCU and the engine-driven fuel pump. On the right-

hand side are installed the propeller controller unit and the starter motor while the oil cooler and the lower level gear housing will be found at the top and bottom respectively.

The compressor casing houses the first and second stage impellers. Air leaving the first stage impeller passes through the first stage diffuser ring, mounted in the front compressor casing. The diffuser ring consists of a number of divergent passages in which the passing air decreases its velocity and increases its pressure. Interstage guide-vanes guide the air to the inlet of the second stage impeller at a controlled velocity and pressure. The rear compressor casing contains the second stage diffuser ring in which the velocity of the air from the second stage impeller is decreased, while the pressure is increased. Air from the second stage of the compressor is delivered to the combustion chambers through seven outlet elbows.

The intermediate casing is bolted to the rear compressor casing. At the forward end a housing carries a gear train driving the accessory gearbox and the centrifugal breather. At the rear side it carries the nozzle box, mounting drum and the turbine bearing housing.

Seven combustion chambers are arranged between the compressor and the nozzle box. Each combustion chamber consists of a cast expansion chamber in which a flame tube is centrally mounted. A fuel burner is fitted in each expansion chamber to spray fuel downstream to the centre of the flame tube. All combustion chambers are interconnected by balance tubes to ensure equal pressures in all combustion chambers and to spread the flame during light-up. Igniters are installed in no. 3 and no. 7 combustion chambers.

The nozzle box outer casing carries seven discharge nozzles, which direct the gas stream from the combustion chambers into an annulus formed by the high pressure nozzle guide-vanes. When the gases from the combustion chambers pass through the convergent passages formed by the high pressure nozzle guide vanes, the velocity is increased, the pressure is decreased and the gas is fed to the first stage turbine blades at the correct angle.

Gas coming from the first stage turbine passes through the intermediate pressure nozzle guide-vanes, which again form a number of convergent passages through which the gas is delivered to the second stage turbine blades and so on for the third stage turbine.

The exhaust unit bolted to the nozzle box consists of an outer cone and an inner cone made of heat resistant steel and has been designed to control the gas flow in such a manner that the lowest possible turbine outlet pressure is obtained. Support fairings between inner and outer cone straighten the gas flow to minimize frictional losses due to the swirl of the exhaust gases.

Reduction Gear and Propeller Control

A double stepdown, triple layshaft reduction gear at the forward end of the compressor turbine shaft provides the drive for the propeller. Helical teeth are used throughout the train; the forward axial thrust of the layshafts being opposed by oil pressure setting on a piston face at the forward end of each layshaft. The oil pressure required to balance the layshaft axial thrust is measured to provide an indication of engine power and is known as torque meter pressure. This pressure is supplied by a gear-type pump incorporated in the reduction gear. The lower layshaft also transmits the drive to the bevel gear assembly actuated in the lower section

of the air intake casing, which in turn drives the fuel pump, oil pumps and propeller control unit by means of output drive shafts.

Starter Drive

The starter drive is taken via a clutch assembly and bevel gears to a sleeve surrounding the high speed pinion shaft. The starter motor runs at twice the engine speed. Nine ratchet teeth, engaging with six pivoted, spring-loaded pawls, are carried by the sleeve surrounding the high speed pinion shaft.
Three pawls and three ratchets engage simultaneously, giving a maximum rotation of 20% before fully rngaging. After engine starting the pawls are disengaged by centrifugal force. A clutch. spring-loaded to 900 pound inches, protects the starter motor against excessive loading and reduces the initial shock when the pawls engage.

Accessory Gearbox Drive

A spur gear, bolted to the front face of the turbine coupling at the rear of the second stage impeller shaft, drives a vertical train of three gears, providing a drive for the accessory gearbox. The first of the three gears incorporates a centrifugal separator to allows air from the engine breather system to pass to atmosphere while retaining lubricating oil inside the engine.

Air Sealing and Cooling System

Air is tapped from several points around the compressor and ducted to various parts of the engine to counteract the spread of heat from the main gas stream and to pressurize labyrinth seals to prevent leakage. Air is also used to supply hot air for de-icing the fuel filter.

Fuel System

The engine fuel system controls the flow of fuel to maintain a satisfactory fuel/air ratio over the whole operating range. Fuel supplied to the engine passes through a fuel heater and a low pressure fuel filter to an engine-driven pump. The pump delivers fuel at high pressure to the fuel manifold and burners via a throttle valve, a back pressure valve and a high pressure fuel valve incorporated in a fuel flow control unit.

Engine-Driven Pump

This unit consists of an engine-driven rotor carrying seven plungers, spring-loaded against a circular camplate.
The angle of the camplate relative to the rotor can be varied through the operation of a hydraulic servo system.
By varying the angle of the camplate, the stroke of the plungers varies and in turn the output of the pump.
The servo system is controlled by the FCU.

Flow Control Unit (FCU)

This unit automatically controls pump output according to the engine requirements under all normal operating conditions.

It will do this by virtue of the position of the fuel throttle valve in the unit and the air intake pressure.
The opening of the valve is determined by the pilots power lever and the trimmer setting. The air intake pressure is fed by a tube to a capsule arrangement inside the unit.

A shut-off valve (HPC) is included in the unit for stopping the engine.

Fuel flow is determined by the opening of the throttle valve and by maintaining a constant pressure difference across it which is obtained by automatic operation of the servo system.

Pressures acting on the servo piston is on one side the pump delivery pressure and on the other side a spring plus a servo pressure produced by feeding pump delivery pressure through a restrictor.
This servo pressure is allowed to return to the fuel pump inlet side through two bleeds which are controlled by spill valves.
The spill valve in the FCU exercises normal control while the one in the fuel pump acts as a safety valve against excessive fuel delivery or engine overspeeding.

The FCU spill valve is carried on a spring-hinged lever which is actuated by a control piston and the capsule assembly.
Variation in pressure drop across the throttle valve caused by power lever movement is transmitted to the control piston which moves the spill valve to alter the bleed.
This alters the servo pressure and the fuel pump stroke is adjusted to deliver the required fuel flow.
Variation of intake pressure acts on the capsule assembly to upset the balance of forces acting on the hinged lever resulting in a change of servo pressure and fuel flow.

The change in fuel flow causes a slightly different pressure drop across the throttle valve which is transmitted to the control piston to restore equilibrium.
At intake pressure higher than standard, the capsule assembly has no effect on control since a pin between the capsules loses contact with the hinged lever.
In case of exessive engine overspeeding, centrifugal pressure generated in the fuel pump is transmitted through a diaphragm and rocker arm to open the spill valve and reduce servo pressure to reduce pump output.

Water/Methanol System

Loss of power at take-off due to high ambient temperature or high altitude is restored or boosted by the injection of water/methanol. Injection is controlled by a control unit, consisting of a metering valve assembly, operated by oil pressure and a control assembly which regulates the oil pressure to the metering valve.

During take-off a controlled flow of W/M is automatically injected in the first stage compressor through drillings in the rotating guide vanes and impeller.
The injection is controlled by a metering unit which is sensitive to propeller shaft torque through torque meter oil pressure, ambient pressure through two opposed capsules and engine speed by interconnection with the power lever.

The W/M control valve is normally held in the closed position by spring

pressure and is opened when the servo control valve admits high pressure engine oil to the servo cylinder.

The servo control valve is arranged to meter engine oil pressure according to the forces acting on it through the torque meter oil pressure mechanism which is opposed by a spring pressure and the effect of atmospheric pressure through two capsules.
Out of balance forces permit movement of the servo control valve to vary the servo oil pressure which acts on the W/M control valve to control the W/M flow into the engine.

The capsules are arranged to move the servo control valve towards the closed position when atmospheric pressure decreases. This controls the take-off power to the ISA value at the particular aerodrome altitude.

As the W/M is vaporized on passing through the compressor it reduces the temperature of the air and increases the mass flow. The increased mass flow reduces the turbine inlet temperature and enables W/M burnt in the combustion chambers to restore engine power to that obtainable at ISA conditions without increasing the gastemperatures above operating limitations.

With the injection system switched on, water/methanol is supplied to the unit as the power lever approaches the take-off position, when, by means of interconnection, the oil cock in the unit is opened to permit engine oil to reach the servo control valve.

Torque Meter System

When torque is being transmitted to the propeller shaft, an axial thrust is produced between the helical teeth of the three reduction gear lay shaft driven gears and the high speed pinion.
This axial thrust is balanced by an opposing oil pressure which is therefore proportional to the engine power.
This pressure, known as torque meter pressure, is indicated through a transmitter on a cockpit gauge.
The torque meter pressure is taken directly to the W/M and automatic feathering systems.

The opposing oil pressure is acting on a piston face at the forward end of each layshaft.
All three pressure cylinders are interconnected and are supplied with oil from a gear-type pump.
The piston in the lower layshaft is arranged to open a control port as it moves rearward and this permits oil to drain to scavenge. Increase in torque will move the layshaft forward and reduce the bleed from the port until the oil pressure has risen sufficiently to restore a balance.

Oil System

The engine oil system is completely self-contained on the engine.
Oil is supplied from the annular oil tank to one pressure pump and is returned through an oil cooler by four scavenge pumps. In addition to lubricating the engine, oil is supplied to operate the propeller and its control unit, the torque meter and water/methanol unit.

Oil from the pressure pump passes through a filter, a filter by-pass valve protects the engine from oil starvation in case of filter blockage.
A compound relief valve gives two controlled oil pressures, one to a maximum

of 35 psi for engine lubrication and to the torque meter pump. The other one to a maximum of 70 psi supplies the water/methanol control unit and the propeller control unit.

Scavenge oil from the main bearings, accessory gearbox drives and reduction gear is returned by four scavenge pumps through a common external pipe to the oil cooler.
Scavenge filters are installed in the return lines to the pump of the reduction gear and the accessory gearbox drive.
The oil cooler returns the oil into the tank over a de-aerator tray to release any air included in the oil.
Air released from the oil in the tank passes via the reduction gear and hollow compressor shaft and the centrifugal breather in the accessory gearbox drive, to atmosphere.

Controls

The engine controls have been designed to permit single engine handling without the use of automatic devices. The fuel control unit and propeller control units are mechanically interconnected to ensure that the optimum selection of fuel supply and propeller pitch is a simple operation. This prevents damage of the turbine by overheating due to the selection of an excessive fuel delivery at a low engine speed. The cockpit controls consist of a power lever and a high pressure cock control lever. To permit an alteration of the relationship between fuel control unit and propeller control unit levers, a fuel trimmer switch, connected to an electrically operated actuator, is installed to suit ambient conditions during engine operation.

If it is necessary to feather a propeller, movement of the HPC lever through a gate beyond the "SHUT" position, ensures that the propeller feathering mechanism is armed and that the fuel supply ceases. Completing the feathering pump circuit, by pressing the feathering switch, ensures complete feathering of the propeller. In order to guard against excessive drag in the event of considerable loss of power from an engine during take-off, provisions are made for automatic feathering of the propeller. The HPC lever may be moved through a gate beyond the open position.
This position is placarded "LOCK-OUT". This operation has no effect on the high pressure control valve itself but only operates a manual cruise lock unlatching system.

Power Plant Drainage System

Directly in front of the nacelle firewall, a drainbox is located into which fuel from all open drains is collected. A stack pipe, fitted in the box, serves as a vent and overflow tube.
The drainbox is connected to the fuel recirculation system which consists of a check valve and a jet pump. Via the suction line of the jet pump the drainbox is drained in the gravity supply line of the collector tank.
Five flush outlets are fitted directly in front of the drainbox.
To remove any further drain fuel, three drain tubes are fitted in the power plant bottom cowling panel.

Five external drains are installed just forward of the collector box.

These drains lead overboard in order to facilitate leak detection should this ever occur.

The drains are as follows:

a. TWo fuel line shroud drains,
b. One fuel heater drain,
c. One water/methanol line shroud drain,
d. One turbine heat shield drain.

If leaks are apparent, the engines must <u>NOT</u> be started until trouble-shooting and rectification action has been taken.

10.0 ENGINE PERFORMANCE AND OPERATION

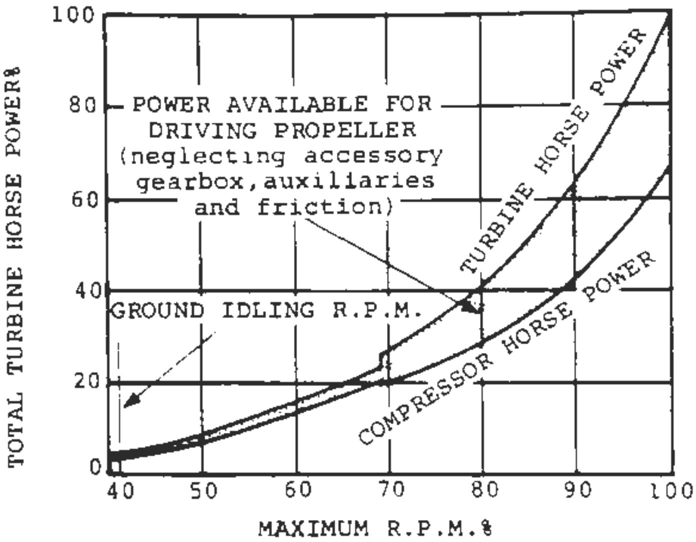
During the introduction to the engine at the beginning of the course we looked at the working principle of the engine, and the general principles used to control the engine within certain limitations to ensure optimum power consistent with useful engine life.

In this note, we will discuss in more detail:

- how control of the engine is arranged to suit a gas turbine/propeller combination
- the effects of variations in pressure altitude and air temperature on engine performance
- what action is necessary to control the engine within its limitations, with changing ambient conditions

Control of the Engine

In the introductory note on "INTRODUCTION TO THE ENGINE" we said that a substantial proportion of the power developed at the turbine is required to drive the compressors. In fact, approximately two thirds of the turbine power is absorbed by the compressors and the diagram below illustrates the power remaining to drive the propeller throughout the engine power range.



Obviously very little power is available to the propeller in the lower engine rpm range, so this must be taken into account in controlling the engine.

CONTROL ON THE GROUND

Let us consider the engine running, at ISA, sea level conditions, at idling speed, and since there is not very much power available to the propeller, if it offers any appreciable resistance to rotation, engine rpm and therefore airflow would reduce, and with the fuel flow selected for the normal idling rpm serious overheating could occur.

This problem could occur in fact anywhere over this lower rpm range and so the controls, and PCU are mechanically arranged so that over the whole of this range the propeller is automatically held in zero pitch, offering the minimum resistance to rotation, and is, in effect, a fixed pitch propeller. Consequently as the power lever is opened towards the flight range, the rpm increase is due to the progressively increasing fuel flow.

Minimum Constant Speed Range.

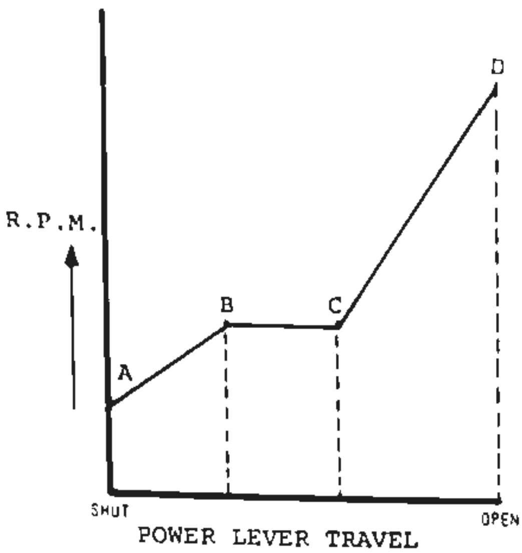
If we continue to open the power lever, we now move towards the normal flight range of the engine. More power is becoming available to the propeller, and we must now make the transition from a fixed pitch propeller to normal constant speed control for flight i.e. the propeller blades must be at some intermediate angle so that they can change pitch as necessary to maintain a selected rpm.

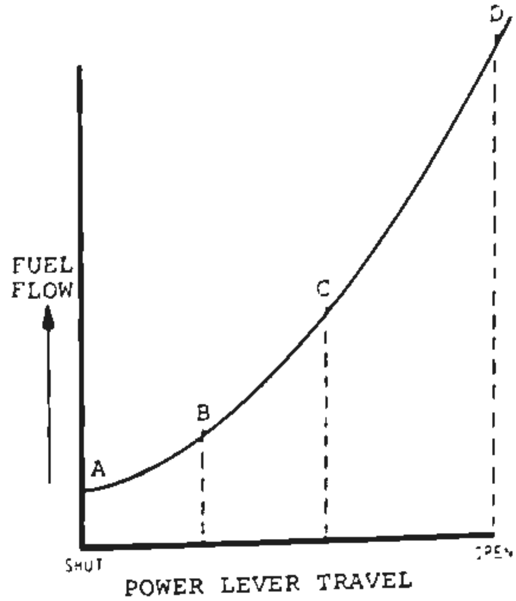
To achieve this as rapidly as possible, as the power lever is progressively opened, there is a range of movement where the rpm remain constant. This rpm band is known as Minimum Constant Speed. The result is that the extra power developed over this range due to the increasing fuel flow, passes entirely to the propeller, which absorbs it by increasing blade pitch.

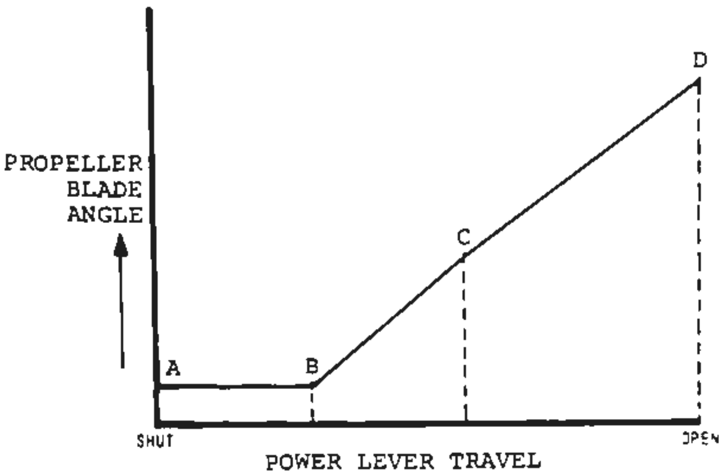
Minimum Constant Speed to Take Off Power.

Any further movement of the power lever brings us into the normal flight range of control, and as the lever is moved towards the Take Off power setting, higher rpm and fuel flow are selected, and the propeller blade angle will increase to absorb the higher power.

This relationship between power lever travel and rpm, fuel flow and propeller blade angle is summarized in the graphs below.





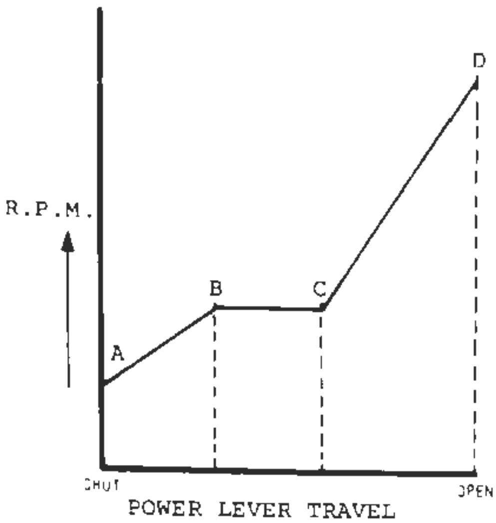


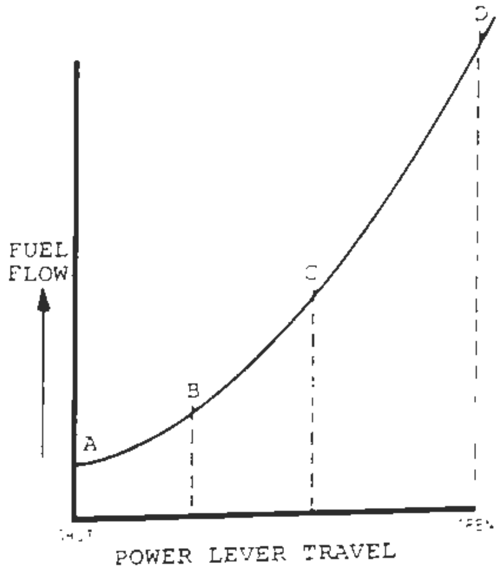
A TO B - IDLING TO MINIMUM CONSTANT SPEED

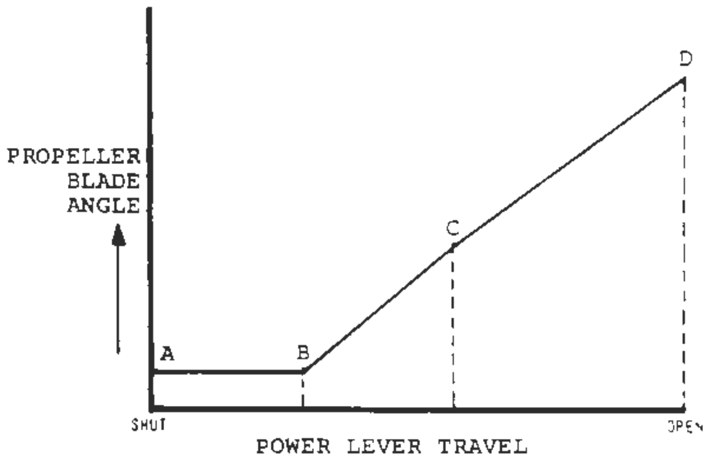
B TO C - MINIMUM CONSTANT SPEED

C TO D - MINIMUM CONSTANT SPEED TO TAKE OFF

This relationship between power lever travel and rpm, fuel flow and propeller blade angle is summarized in the graphs below.







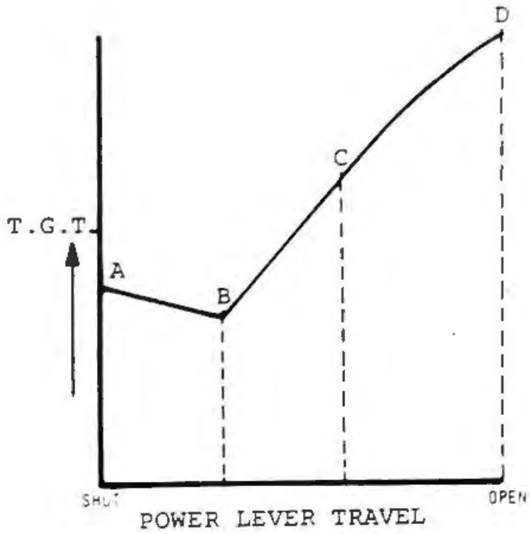
A TO B - IDLING TO MINIMUM CONSTANT SPEED

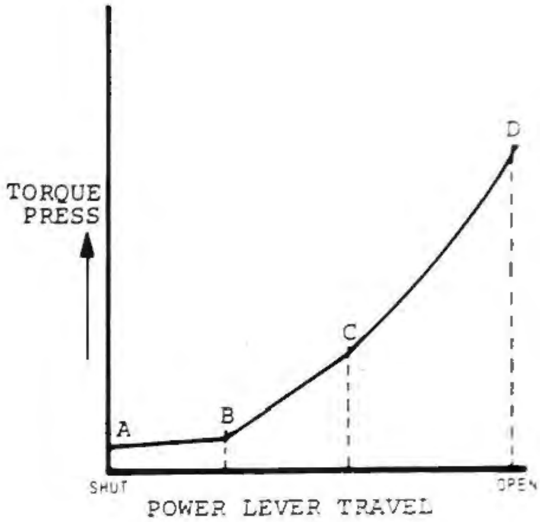
B TO C - MINIMUM CONSTANT SPEED

C TO D - MINIMUM CONSTANT SPEED TO TAKE OFF

rpm and Fuel Flow, of course, are two of the parameters we use for monitoring engine performance. Before going any further, let us see what effect this interconnection of rpm and fuel flow control has on the other parameters, TGT and torque pressure.

Remember that TGT is basically an indication of the fuel/air ratio in the engine, so it will vary as that ratio varies; and also that the torque meter system indicates power transmitted through the reduction gear.





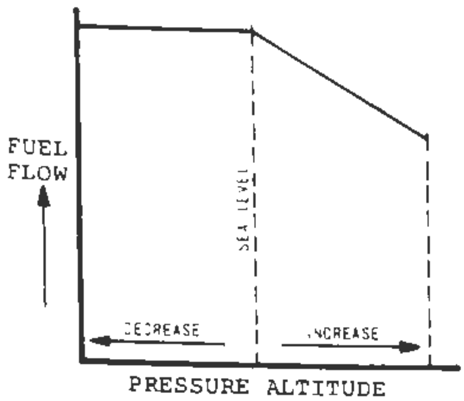
- As the power lever is moved from idling to minimum constant speed, the TGT will fall slightly (this is due to improved engine efficiency) and torque pressure will be negligible since very little power is available to the propeller.

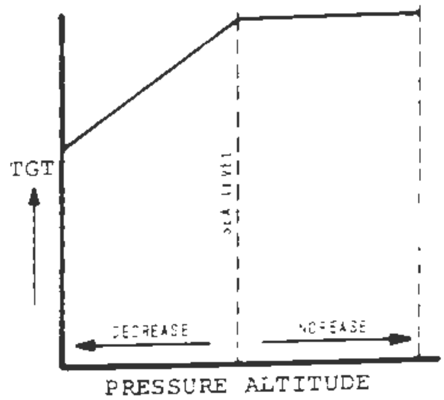
- Over the minimum Constant Speed range, fuel flow is increasing while rpm remain constant, and so the fuel/air ratio will be changing and we see a significant rise in TGT Constant rpm means that no increase in power is required to drive the compressor, and so the extra power developed over this range is wholy available to the propeller, and torque pressure now rises quite rapidly.

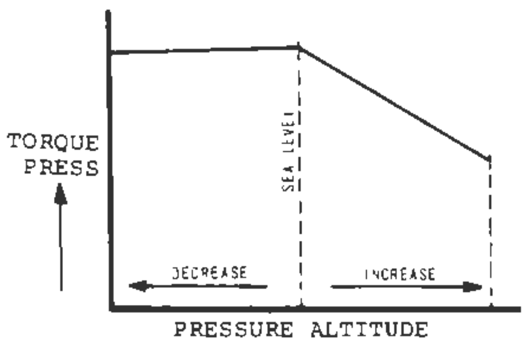
- Once the power lever is moved past the Minimum Constant Speed rang, higher rpm and fuel flows are progressively selected, and TGT and Torque Pressure increase until the optimum values are reached at the Take Off power setting.

- Increase in Air Intake Pressure

  If the intake pressure increases, for instance due to a reduction in pressure altitude, the fuel flow will automatically increase but only until the intake pressure reaches the ISA Sea Level value. At this condition the engine is giving maximum power, and any further increase in intake pressure is not accompanied by an increase in fuel flow, which is held at the ISA S.L. value. Consequently an increase in mass air flow at constant fuel flow will result in a fall in TGT, which is accompanied by a fall in Torque Pressure.





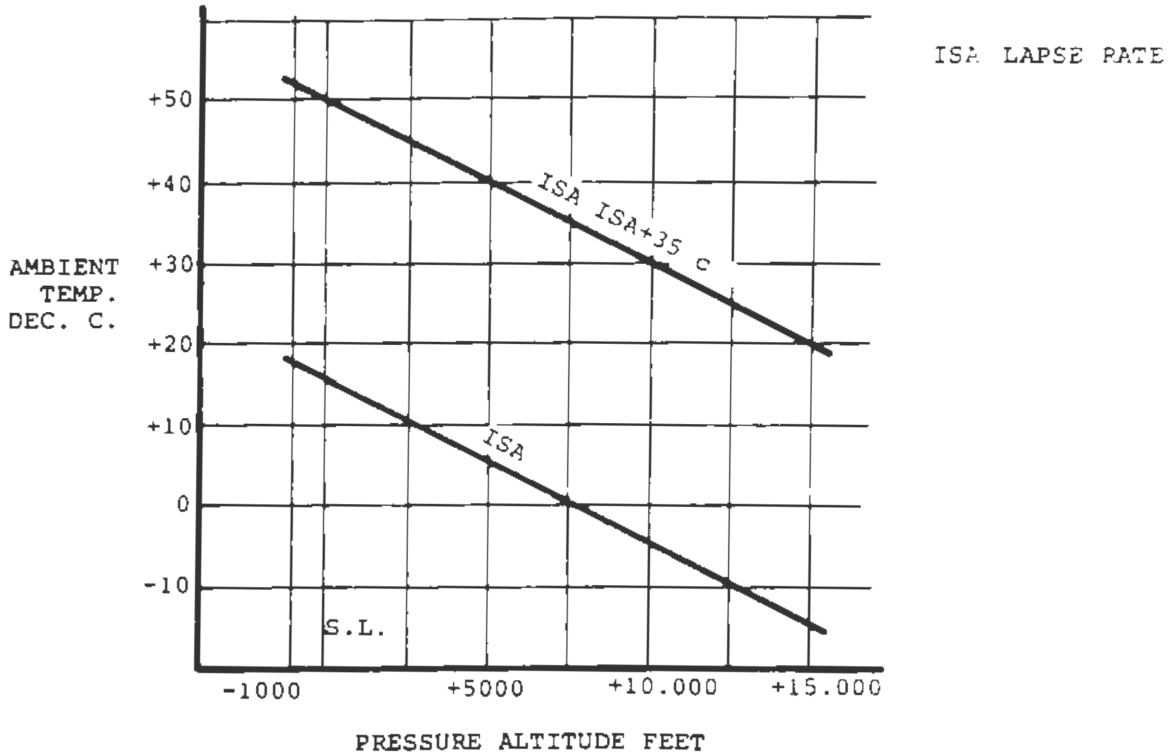


THESE GRAPHS ASSUME THAT THE RPM IS CONSTANT AND THAT THE TEMPERATURE IS ISA

The effects of changes in pressure altitude are summarized in the graphs. You will appreciate that the effects will be similar at any fixed power lever setting in the normal constant speed range of the engine, with the Fuel Flow, TGT and Torque being limited to the ISA Sea Level value for the particular power lever setting.

- Changes in Ambient Temperature

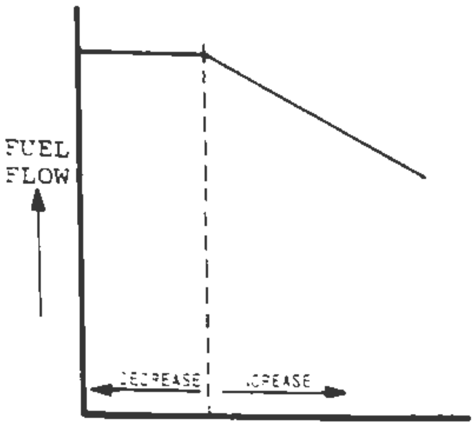
It was stated earlier that changes in ambient temperature would also result in a change in mass air flow through the engine, with similar results to those discussed for changes in pressure altitude. At any given pressure altitude the fuel flow will be automatically adjusted to the correct ISA value by the capsule assembly in the FCU.

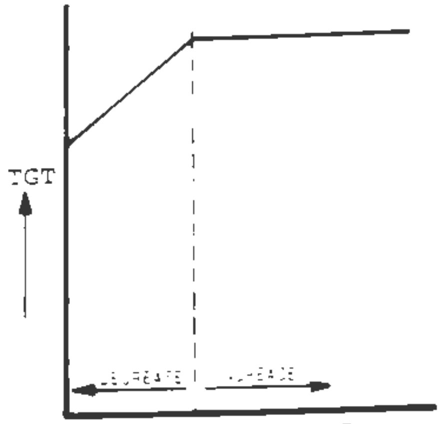


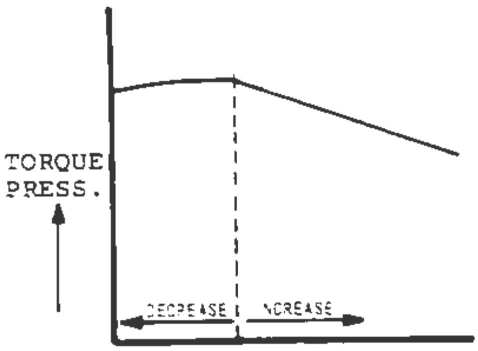
However, any rise in ambient temperature above the ISA value would result in a reduction in mass air flow and associated rise in TGT which is not corrected by the capsule assembly. A manual control, the fuel trimmer, is provided to control the fuel flow to maintain the TGT within limits whenever the engine is operated in high ambient temperatures.

Just as the automatic reduction in fuel flow at altitude reduces power, the progressive use of the trimmer will also reduce engine power. At temperatures below ISA, the mass air flow increases, but you will remember that engine power is limited to the ISA Sea Level value, and so, at ISA and temperatures below, fuel trimmer will be set to FULL INCREASE, i.e. selecting the maximum fuel flow.

Therefore as ambient temperature falls below ISA the TGT will fall as the fuel/air ratio changes. At first this has no appreciable effect on torque pressure, but at low ambient temperatures this too will fall.







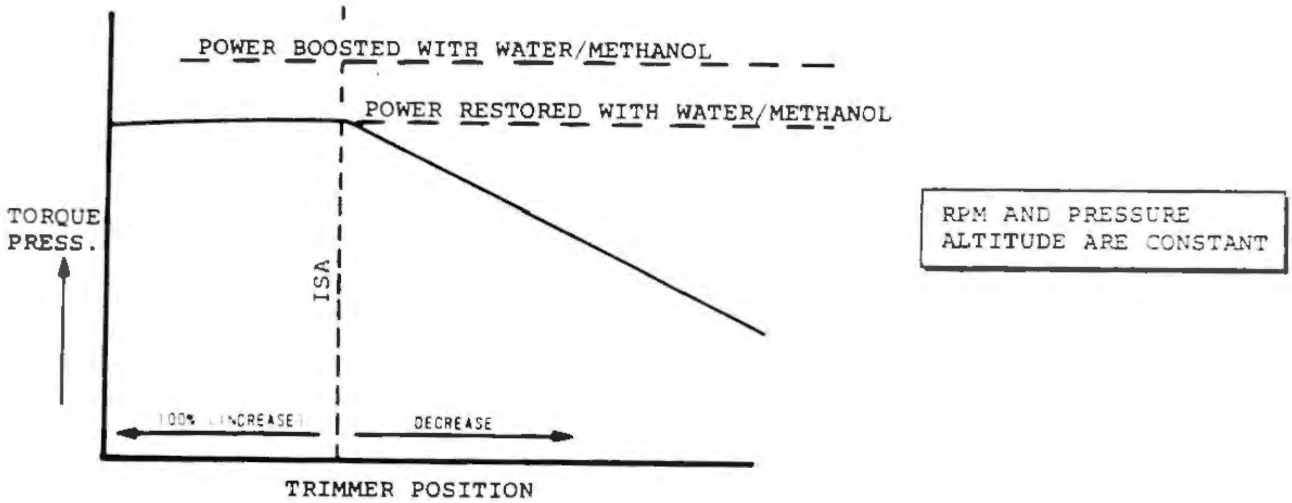
THESE GRAPHS ASSUME THAT THE RPM AND PRESSURE ALTITUDE ARE CONSTANT

The graphs above summarize the effects of changes in ambient temperature at S.L. conditions, but, the effect is similar at any given pressure altitude when rpm is selected to a constant speed value by the throttle. The fuel trimmer will be at FULL INCREASE i.e. maximum fuel flow, at ISA temperature, and would be used as necessary at ambient temperatures above ISA.

Effect of Humidity

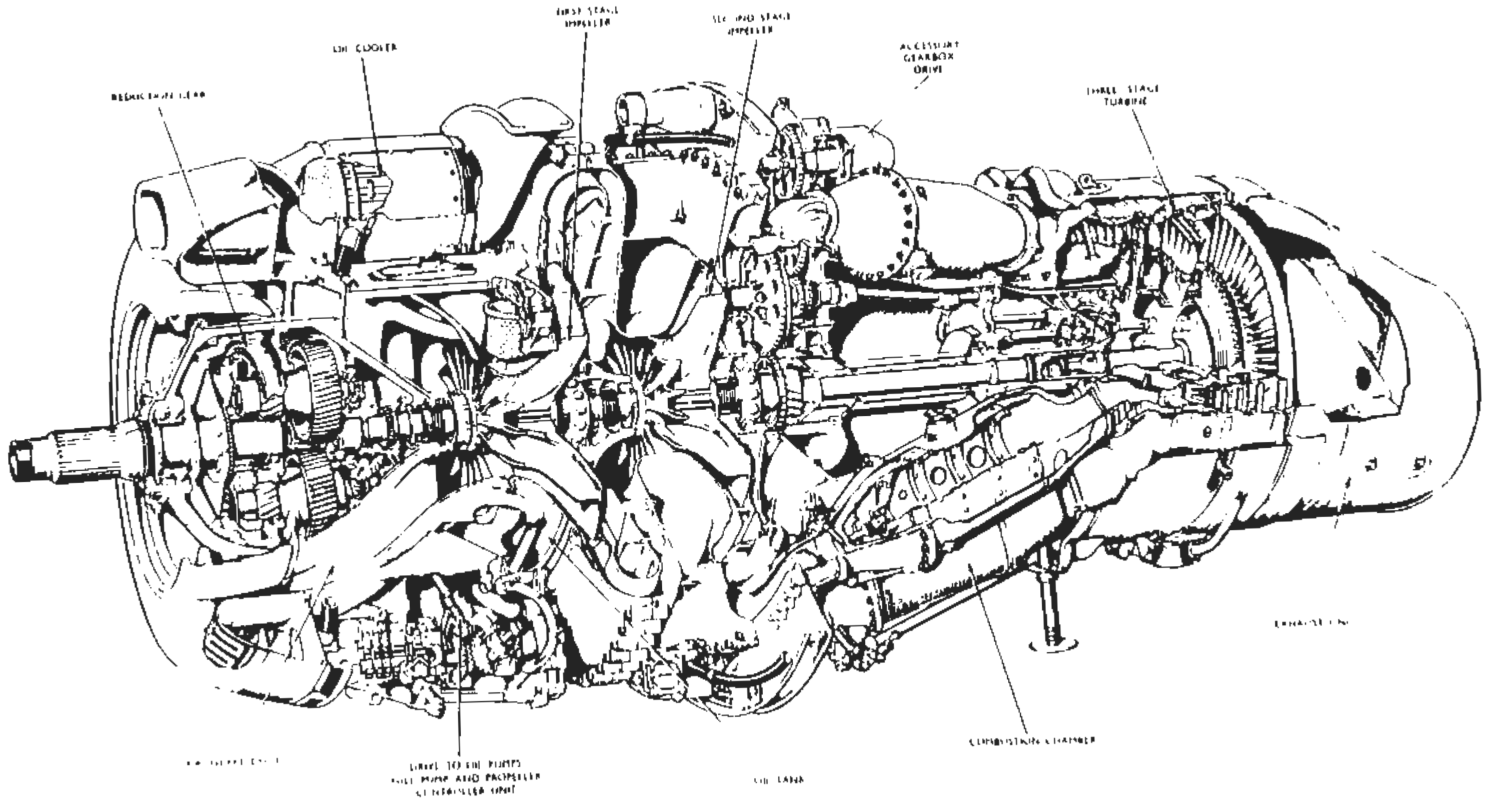
If the engine is run in conditions of high humidity, engine performance will be affected, because the water vapour present reduces the mass air flow through the engine. This, as we have seen, will result in higher TGT's, and to control the TGT within limits, additional use of the fuel trimmer, over and above any trimmer setting for high ambient temperatures, will be necessary, with a consequent reduction in power.

Humidity however is not normally a problem unless it is associated with high ambient temperature. It will present no problem to the pilot because the water/methanol system would be used at take-off in these conditions, and this either boosts power or restores it to te ISA value, depending on engine mark number irrespective of the fuel trimmer position, as illustrated in the graph below.

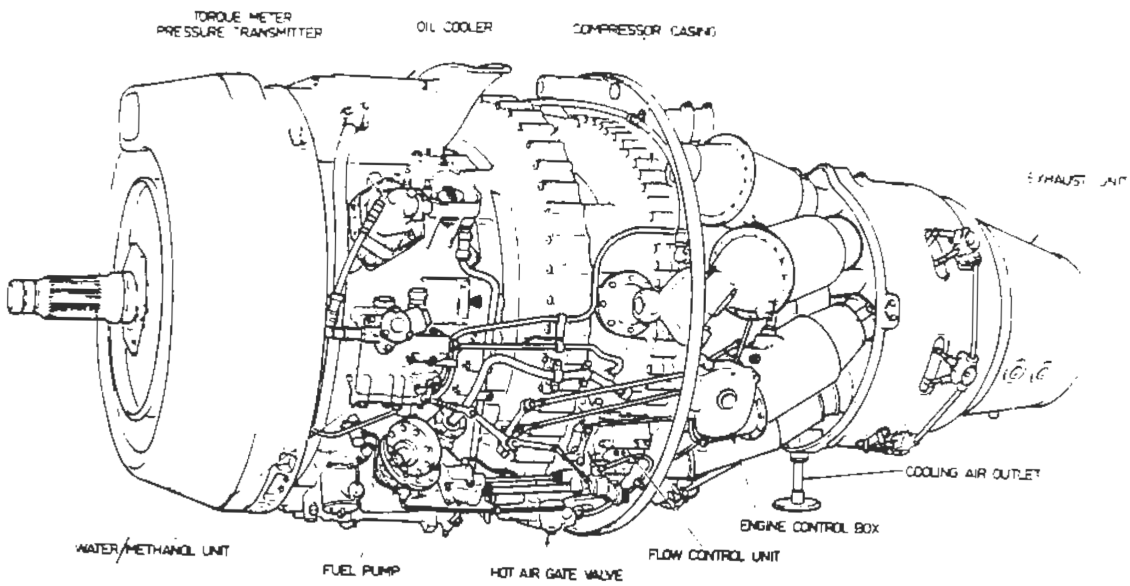


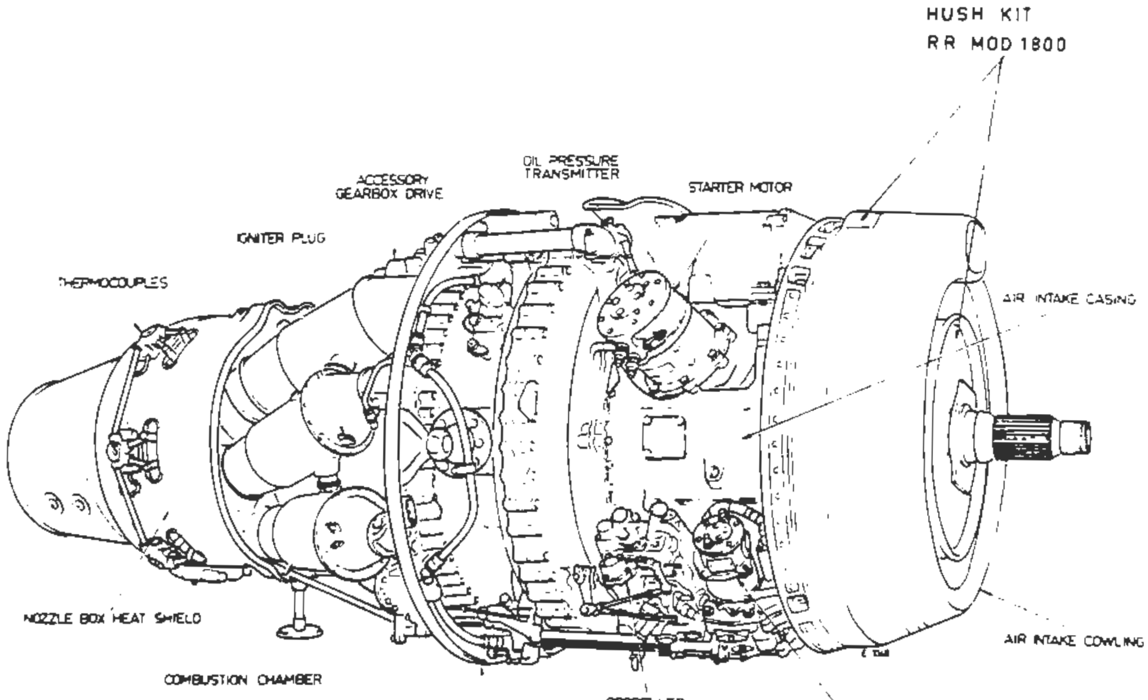
The engineer will, however, have to take into account the effects of humidity on certain occasions when checking engine performance. We will discuss both the procedures and occasions in more detail later in this note and during the lectures on Ground Running.

Having seen the effect of ambient conditions on the engine, we can now see how this affects the control of the engine, and how we monitor performance. To do this we must know what limits apply to the engine, and where these are recorded and, since these are different for pilot and engineer, we will discuss flight handling and ground running separately.

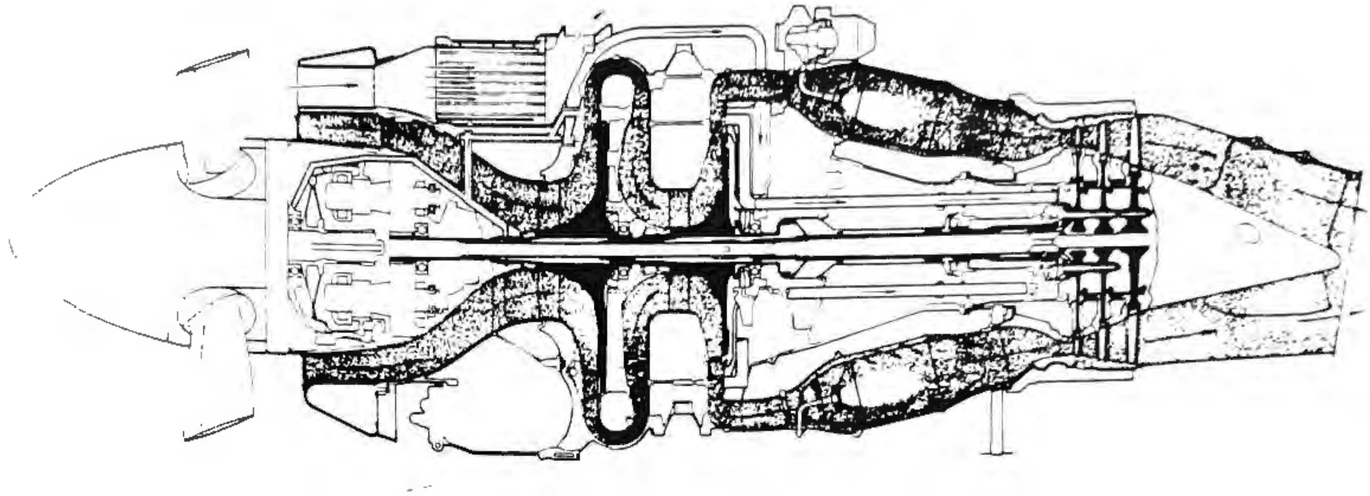


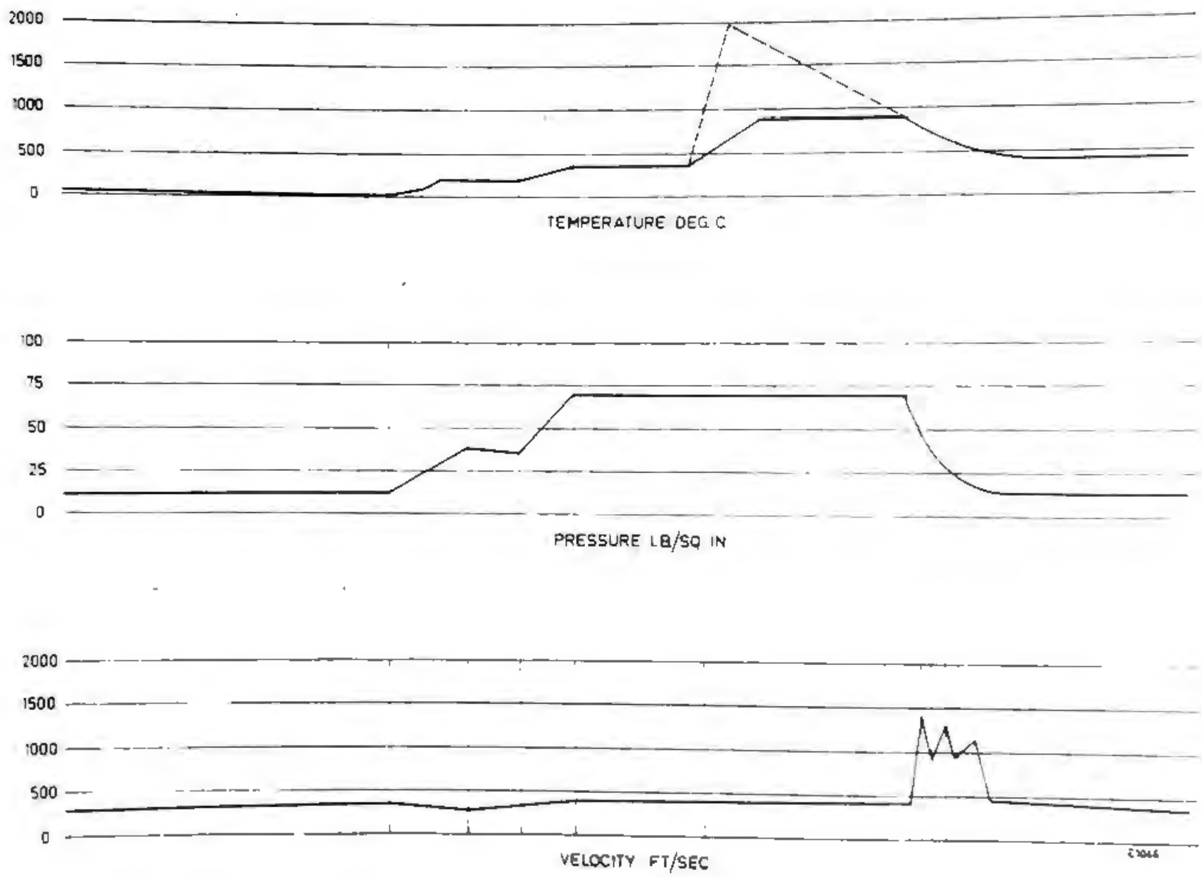
ROLLS ROYCE "DART" RDa-7



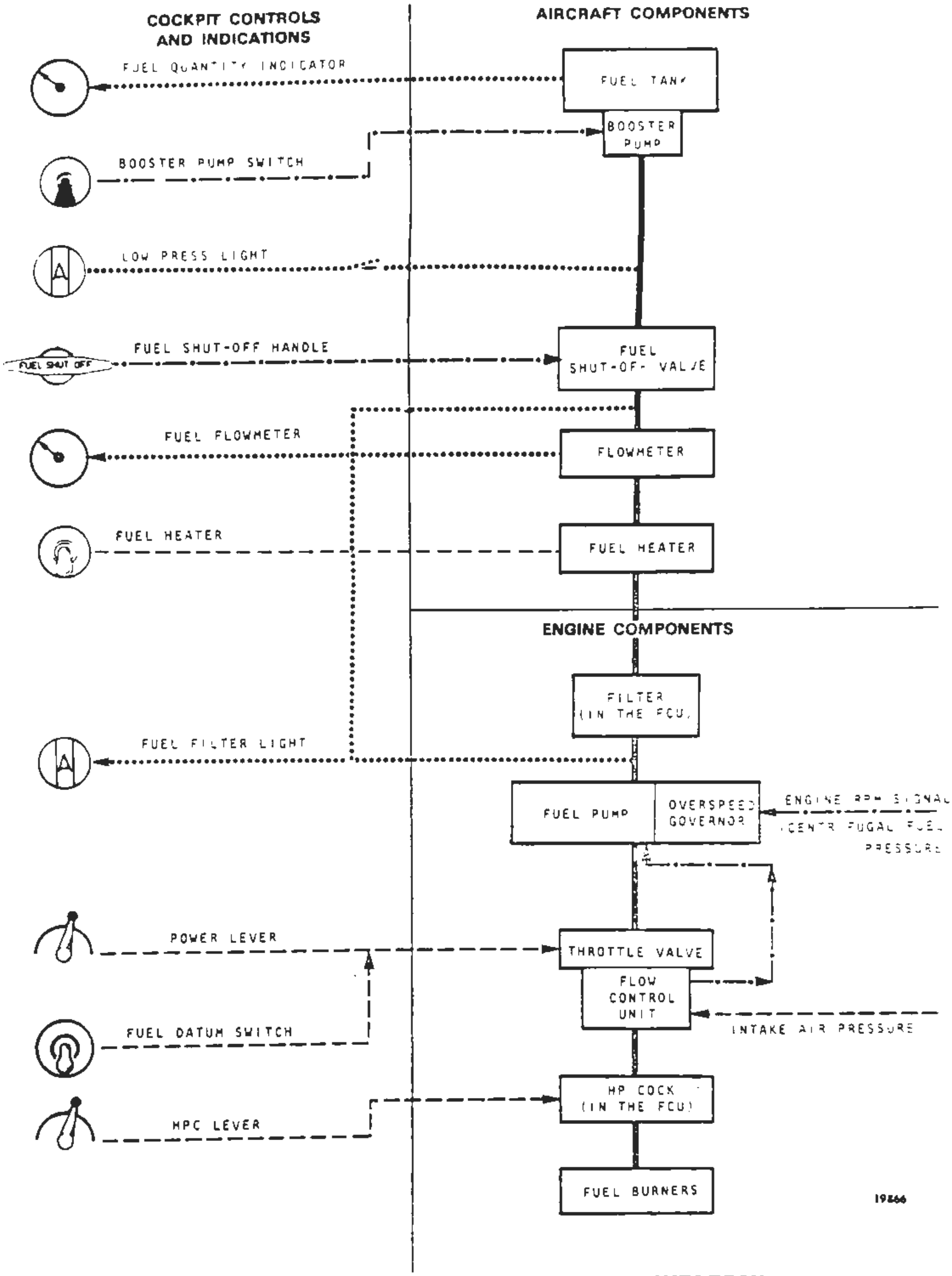


"DART" RDa-7 ENGINE

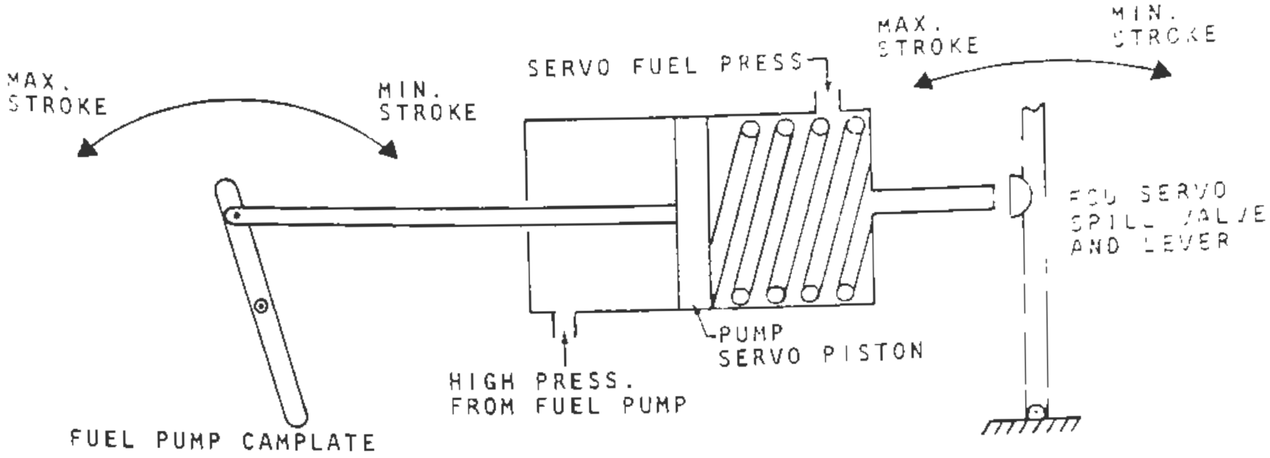




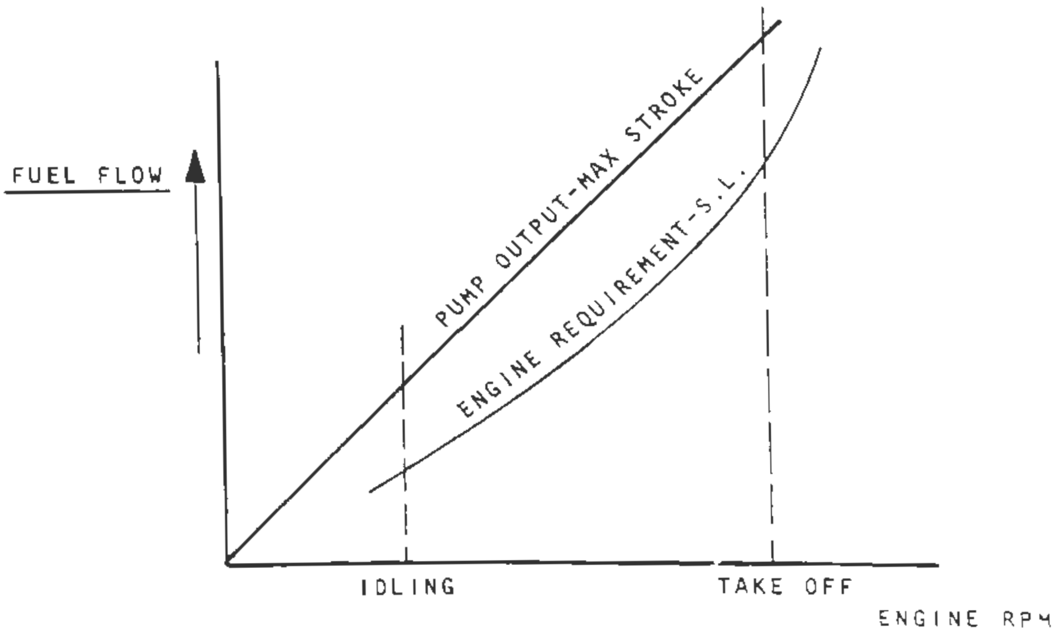
GAS FLOW DIAGRAM "DART" RDa-7 ENGINE



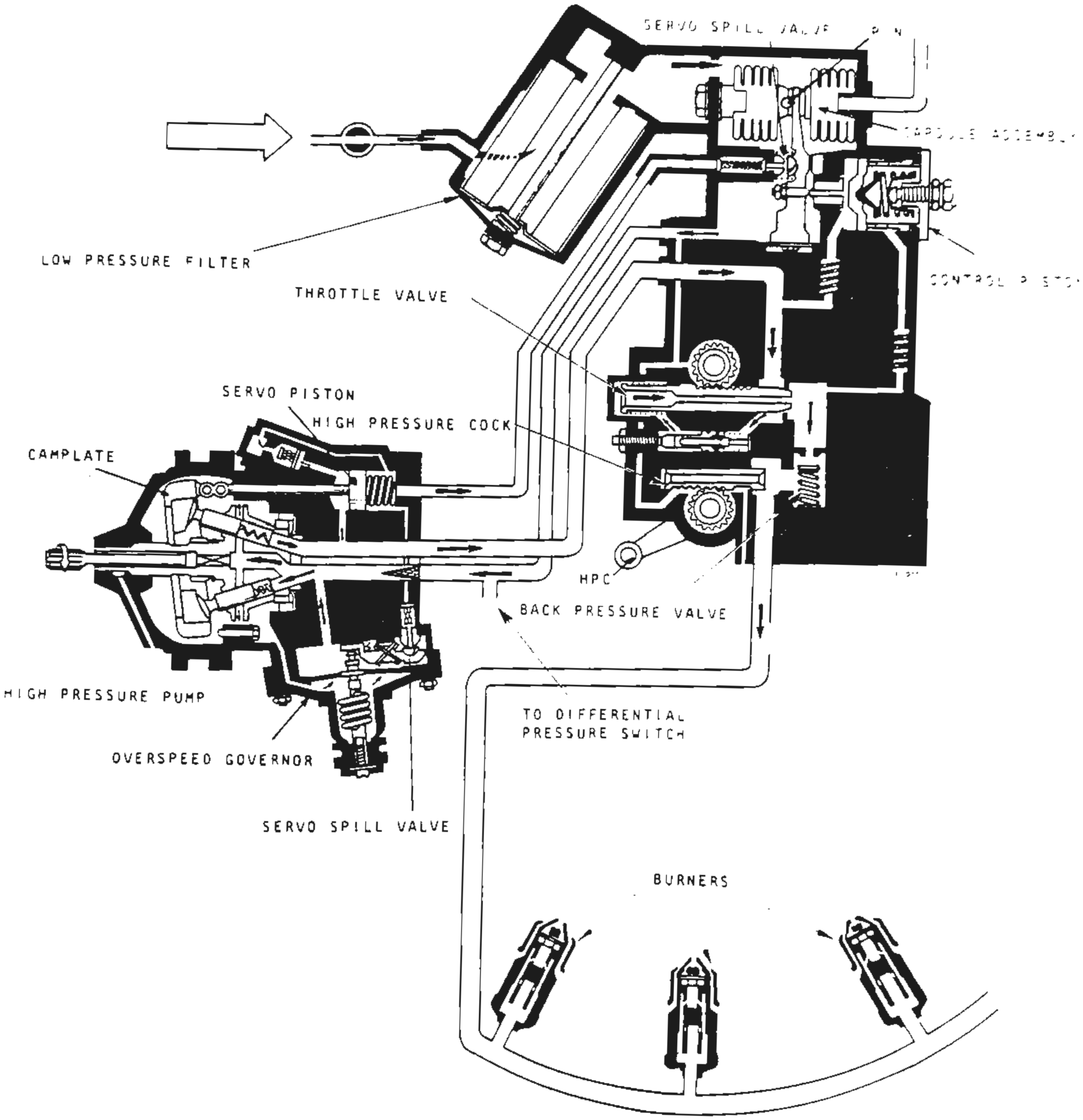
DART FUEL SYSTEM - BASIC PRESENTATION



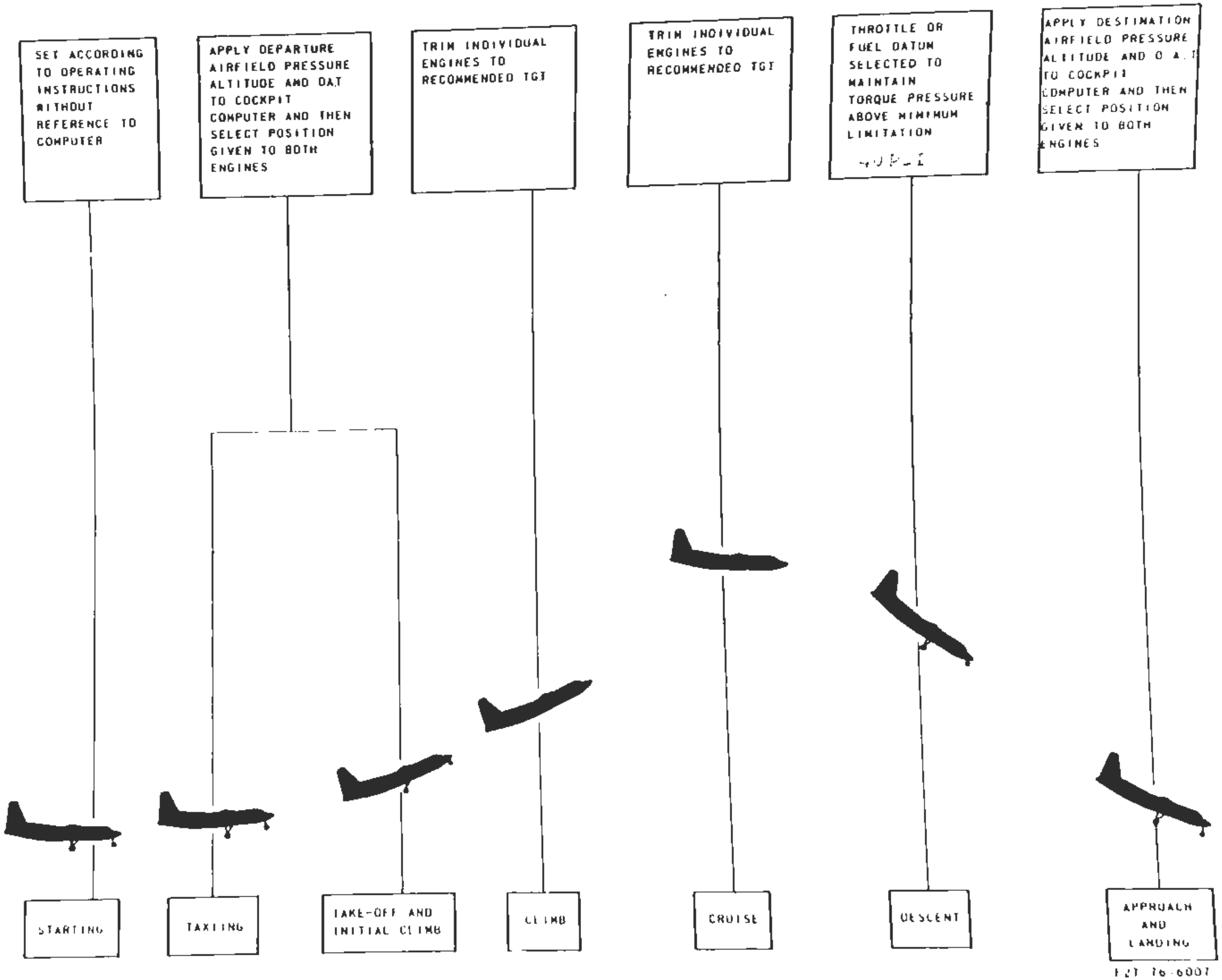
ENGINE FUEL PUMP



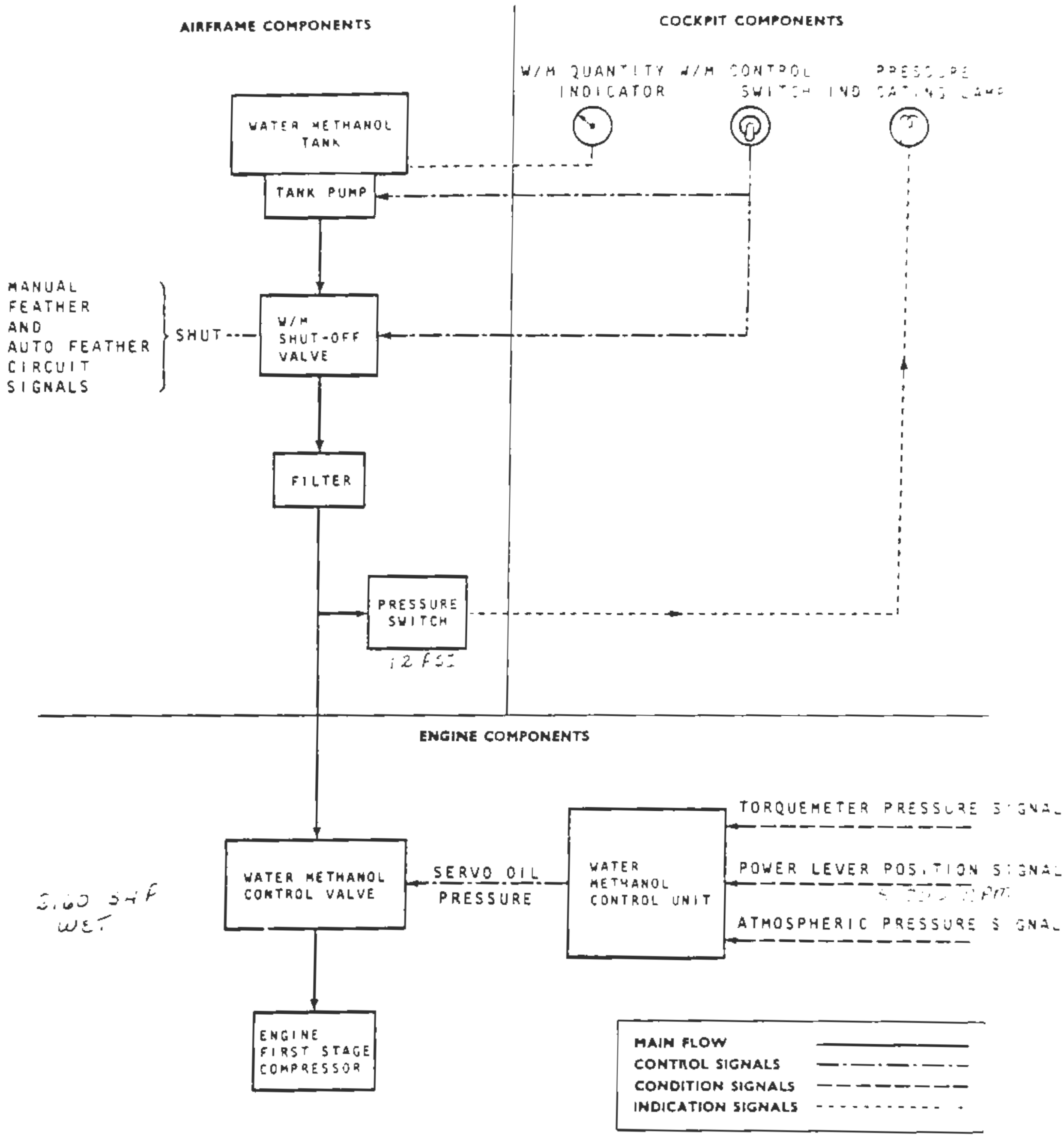
FUEL PUMP PERFORMANCE



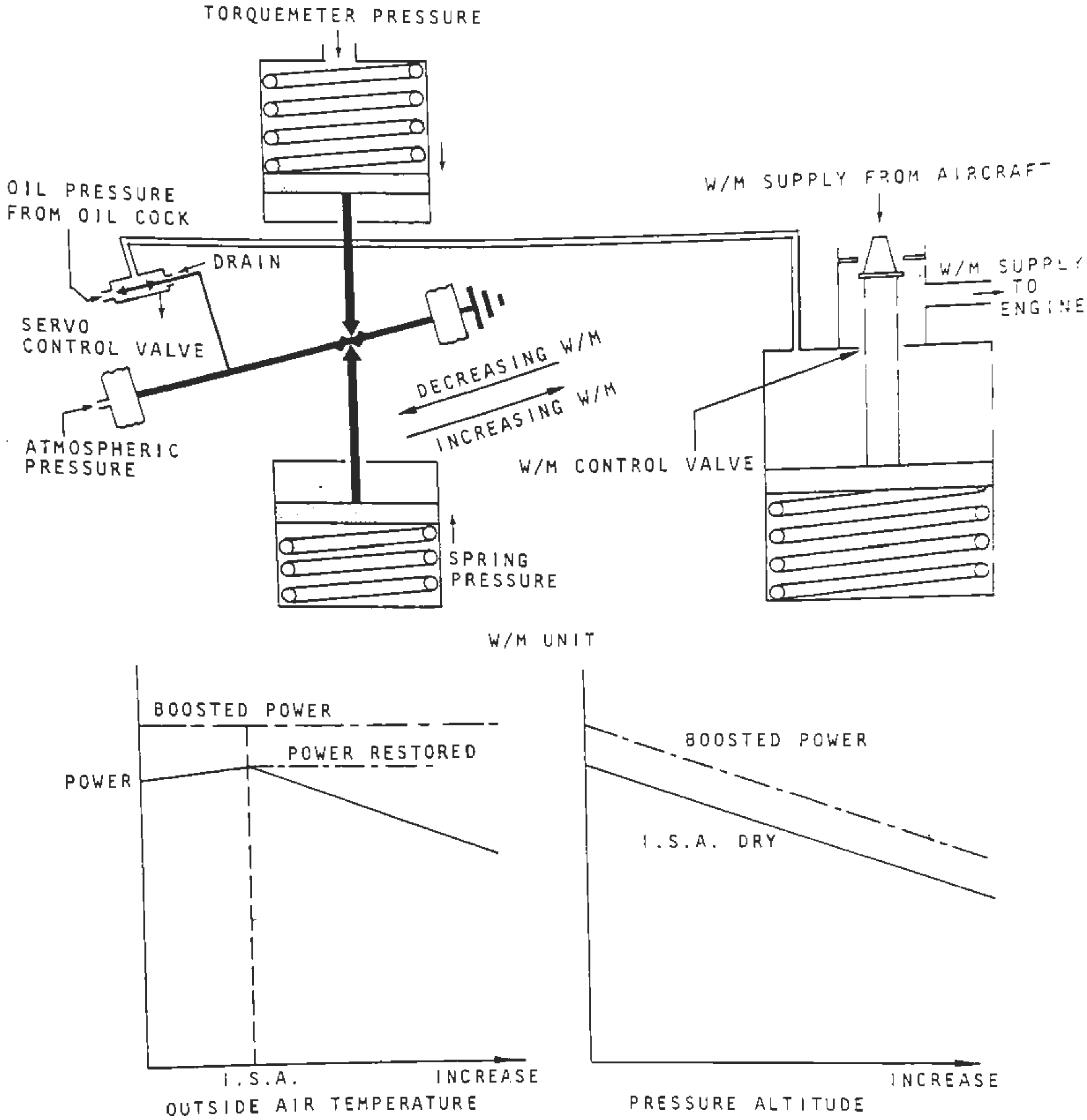
"DART" ENGINE FUEL SYSTEM



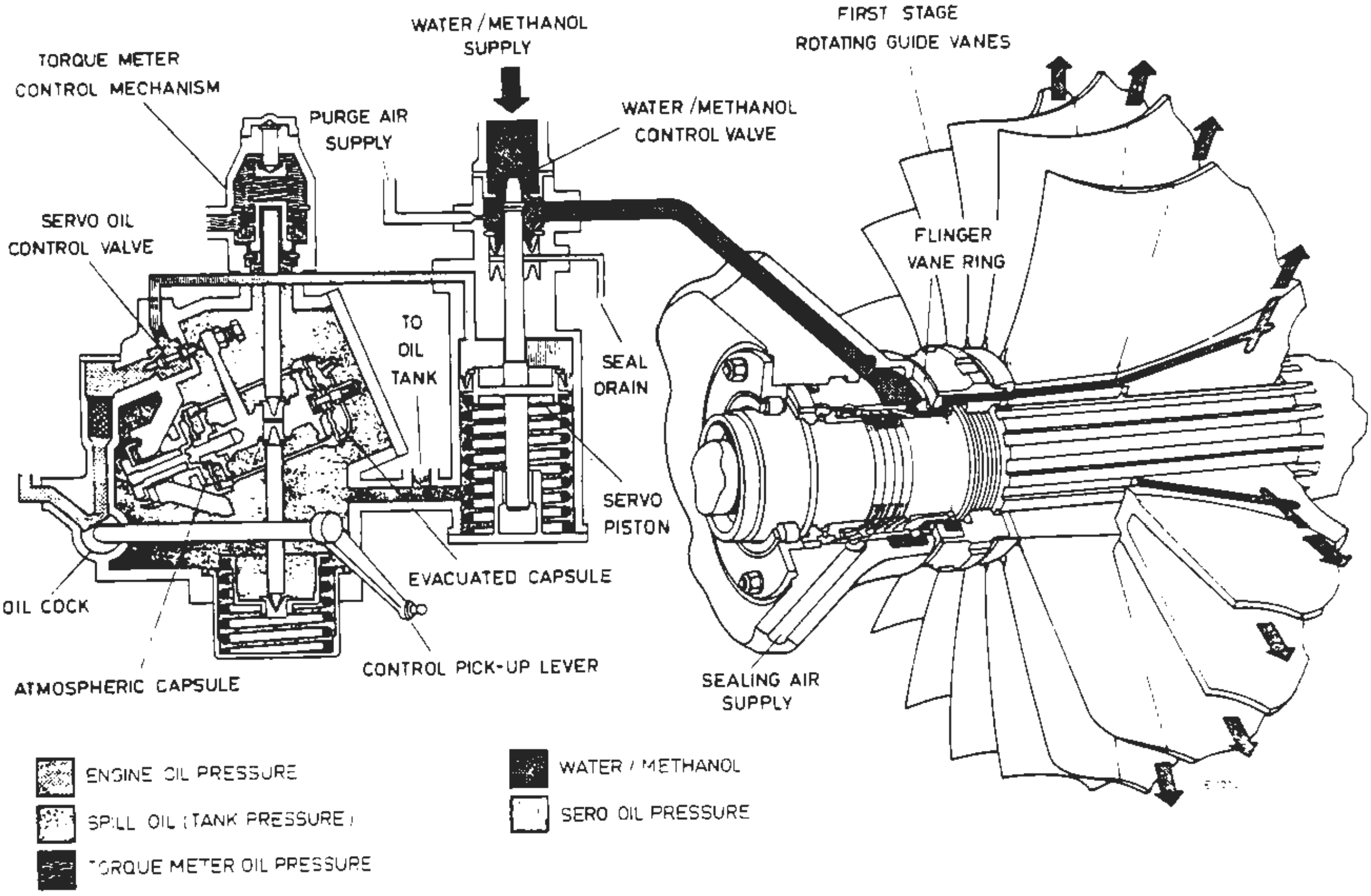
USE OF FUEL DATUM



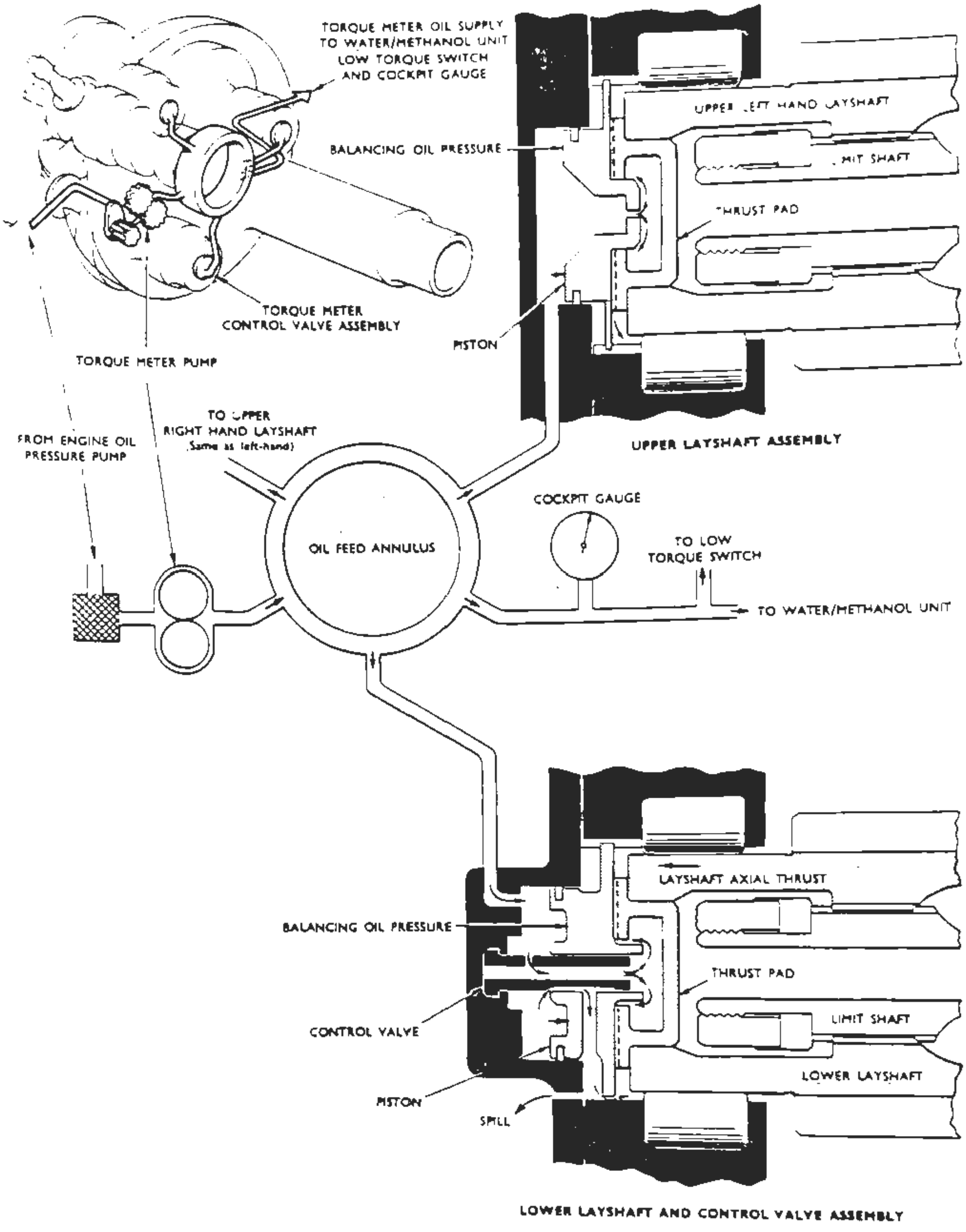
DART WATER METHANOL SYSTEM - BASIC PRESENTATION



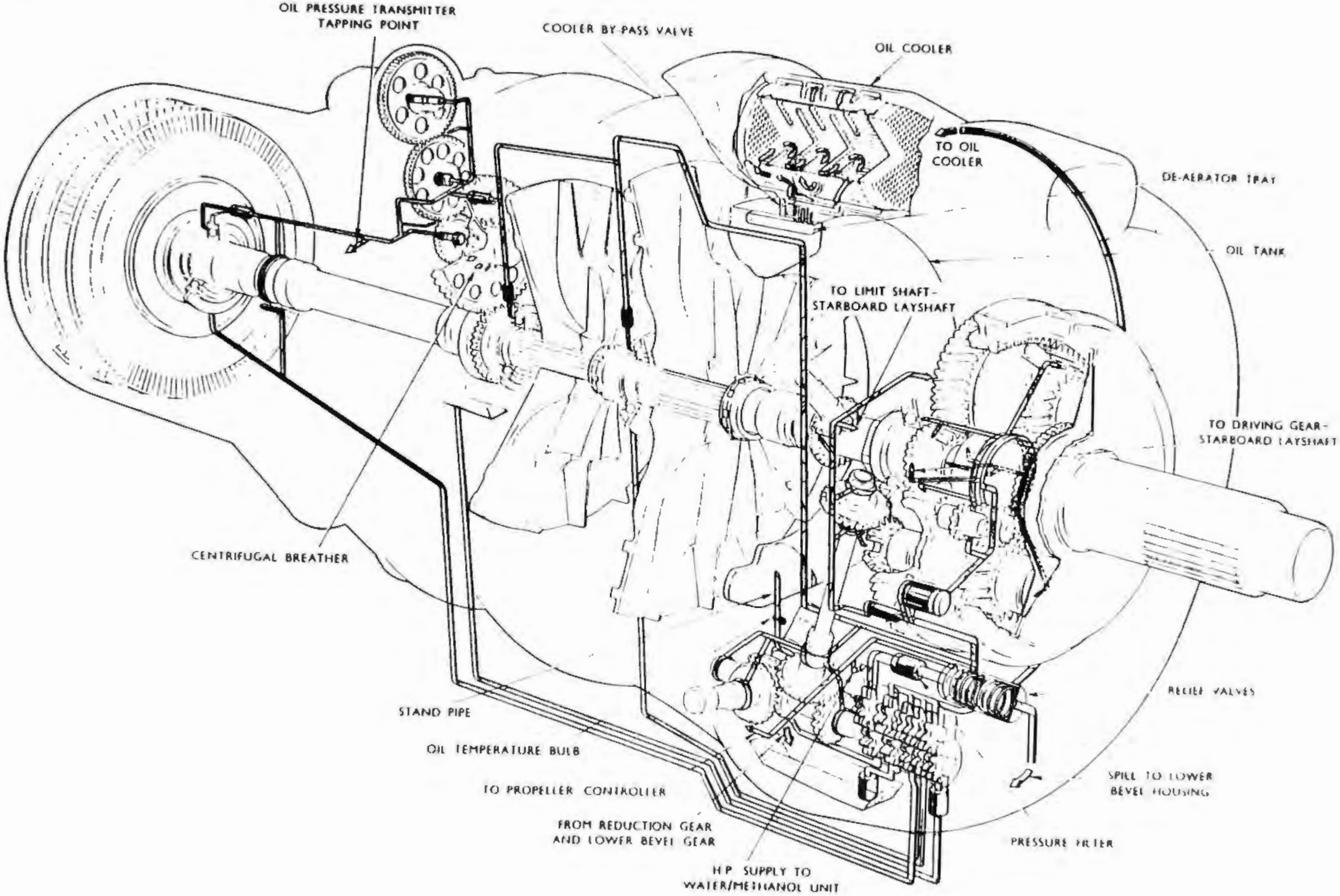
WATER-METHANOL PERFORMANCE



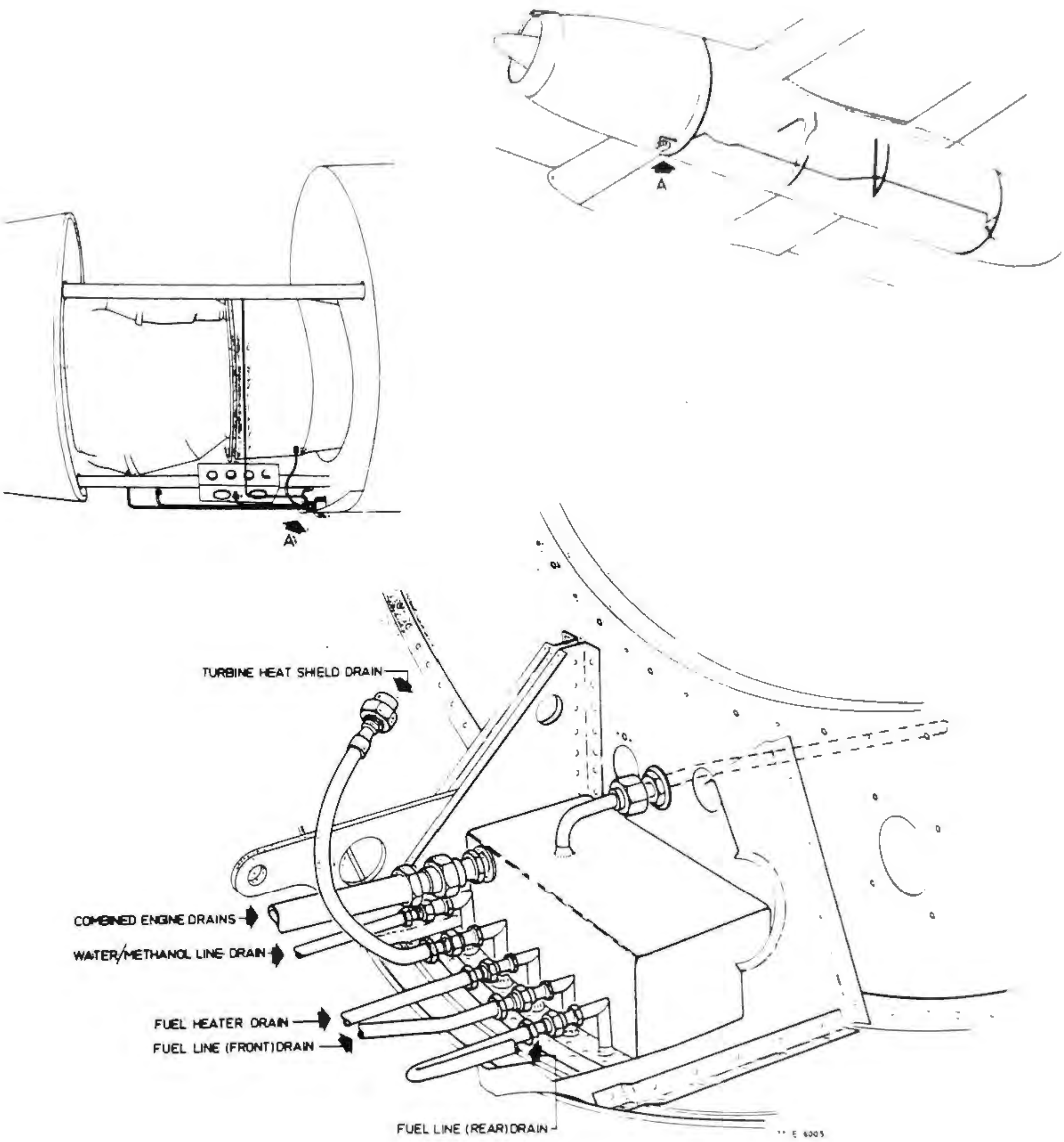
"DART" ENGINE WATER/METHANOL SYSTEM



"DART" ENGINE TORQUE METER OPERATION

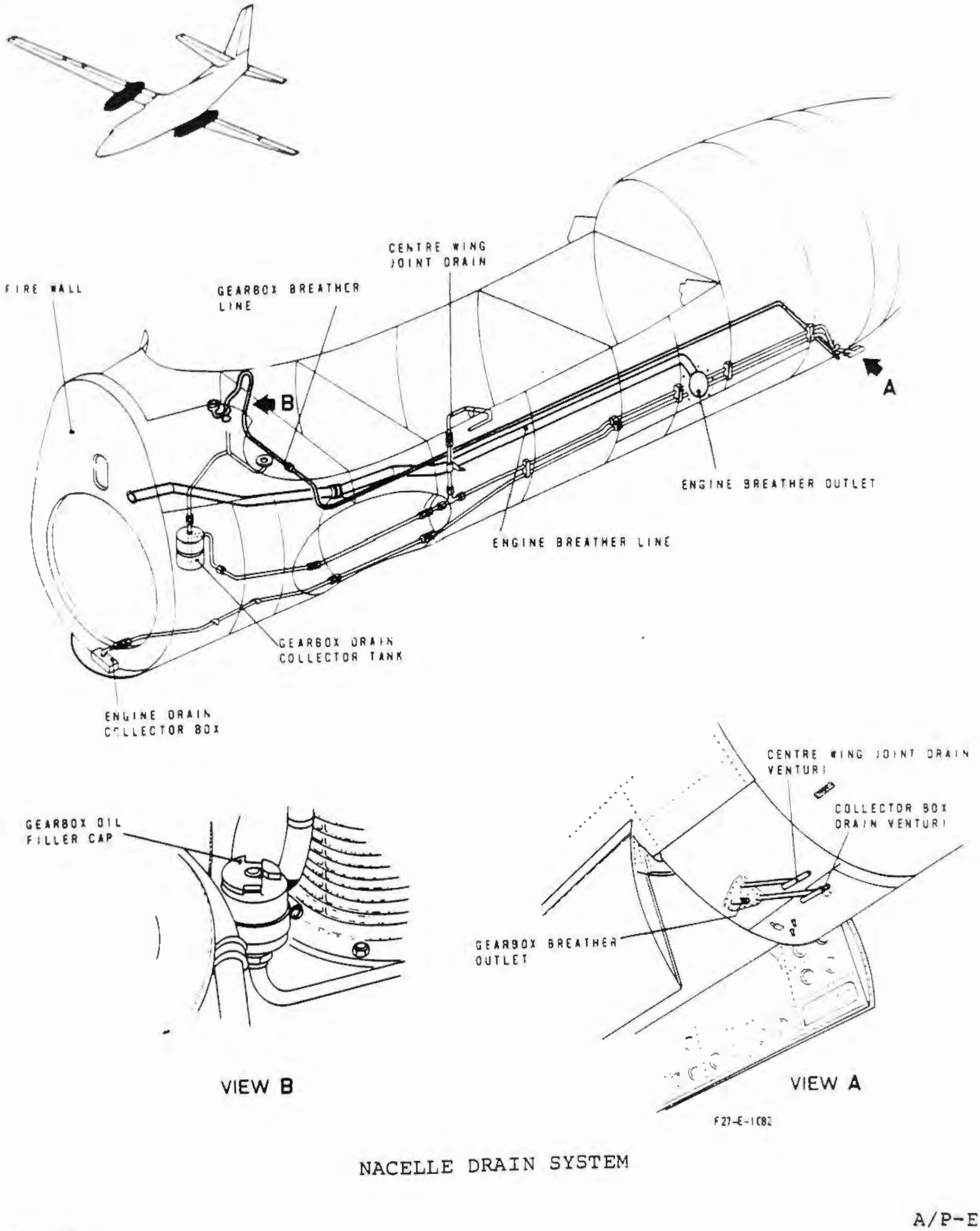


"DART" RDa-7 OIL CIRCULATION DIAGRAM



DETAIL A

POWER PLANT DRAINAGE SYSTEM



NACELLE DRAIN SYSTEM

ENGINE FUEL AND CONTROL 73

73. ENGINE FUEL AND CONTROL

00.0 GENERAL

The description and operation of the engine fuel system is divided into two sub-systems, the distribution system and the cockpit indication system.

The purpose of the engine fuel system is to match the fuel delivery rate automatically to the engine requirement, under all operating conditions, and to deliver the fuel to the combustion section in an atomised spray for efficient burning. The pilot is given control of engine speed and the fuel system ensures that the engine operates within safe limits.

Distribution system.

Fuel, supplied to the engine, passes through a fuel heater and a low pressure fuel filter to an engine-driven plunger pump. The pump delivers fuel at high pressure to the fuel manifold and burners via a throttle valve, a back pressure valve and a high pressure fuel valve incorporated in a Fuel Control Unit (FCU). The fuel control unit is metering the fuel flow in the normal acceleration-, steady running- and deceleration conditions.

The fuel flow is controlled for starting and stopping by a High Pressure Cock (HPC), to admit fuel to the engine during starting and operation, and to shut off the fuel to the engine during engine shut-down.

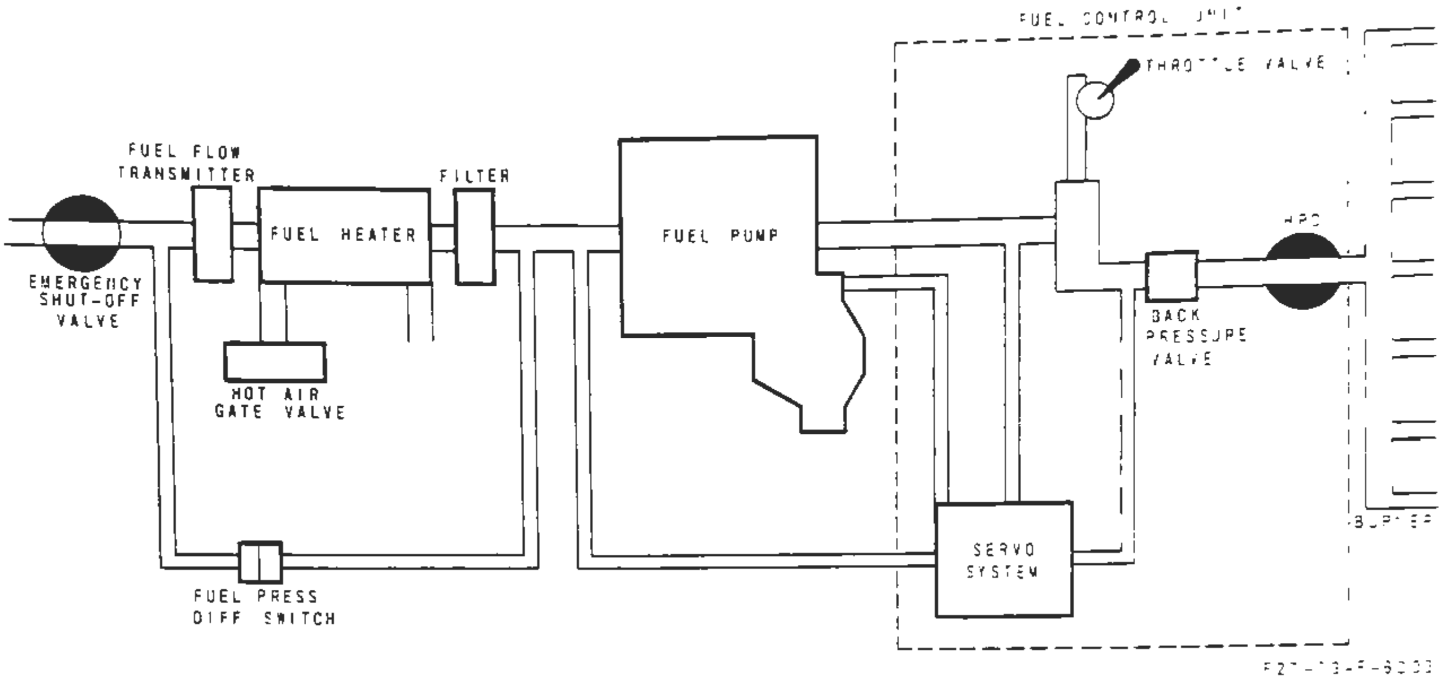
31.0 FUEL FLOW AND CONSUMED INDICATING SYSTEM

A combined fuel flow and fuel consumed indicator is installed on the main instrument panel. The function of the fuel flow/consumed indicating system is to provide the crew with a visible indication of the fuel flow to each engine and the fuel consumed by each engine.

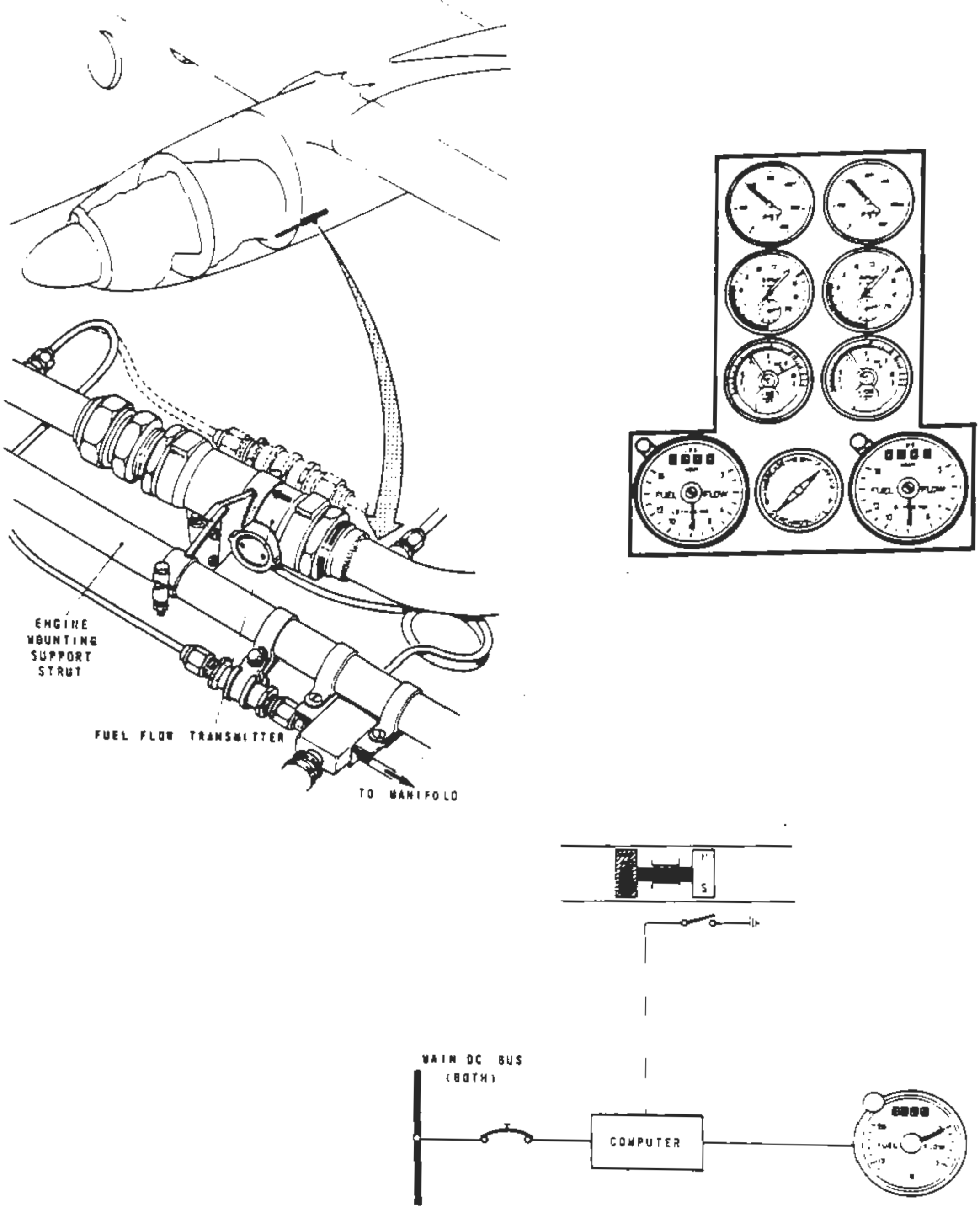
The fuel consumed indicator is used in conjunction with the fuel flow indicator. A reset button enables to reset the digital counter to zero, when required.

The "KENT" fuel flow indicating system consists of three main components: a transmitter, a computer and an indicator.
28 volt DC is required for the operation of the system.
The transmitter incorporates a twin helical-bladed rotor assembly, a rotating permanent magnet and a pick-off coil.
The transmitter rotor and magnet are driven by the mass fuel flowing through it and the pick-off coil supplies electrical input signals to the computer.
The input signals are modified in the computer before they are transmitted to the indicator which is basically a moving coil meter.

END



ENGINE FUEL SYSTEM



FUEL FLOW SYSTEM (KENT)

75

AIR

75. AIR

20.0 POWER PLANT COOLING AND VENTILATING AIR SYSTEM

The power plant area is divided into four zones as follows:

Zone I is the section of the power plant compartment forward of the engine heat shield at Sta. 896.
This zone receives ventilating air from three rectangular inlets, one on each side cowling and one on the bottom cowling.
The exhaust outlet for this zone is located on the top cowling, to the left of the oil cooler outlet.

Zone II is the space between the engine heat shield and the aircraft fire wall.
This zone is provided with two inlets: one at the bottom left side and one at the top right side cowling panel.
The air is exhausted through the annular space between the engine exhaust cone and the jet pipe.
The engine exhaust gas efflux into the jet pipe has an ejector effect and scavenges the airflow.

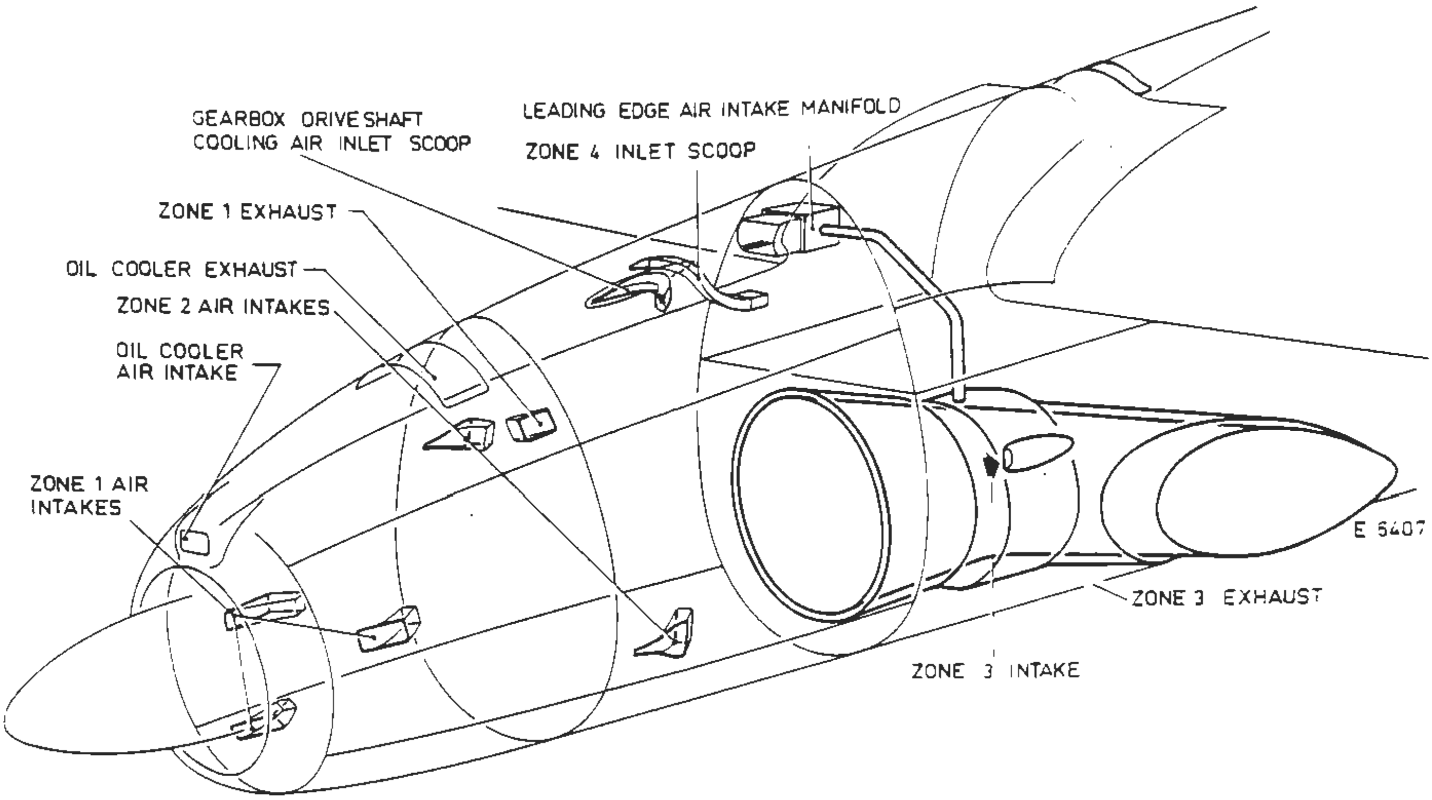
Zone III is the nacelle area containing the jet pipe shroud.
This zone is ventilated by an air inlet scoop located on the outboard side of the nacelle.
Ventilation air is exhausted through a recessed outlet located in the bottom of the nacelle, just forward of the landing gear doors.
The annular space between the jet pipe and its shroud is ventilated through an air duct which is tapped off from the Generator cooling air intake in the centre wing leading edge.

NOTE: The air is tapped off before it passes around the electrical apparatus to avoid contamination.

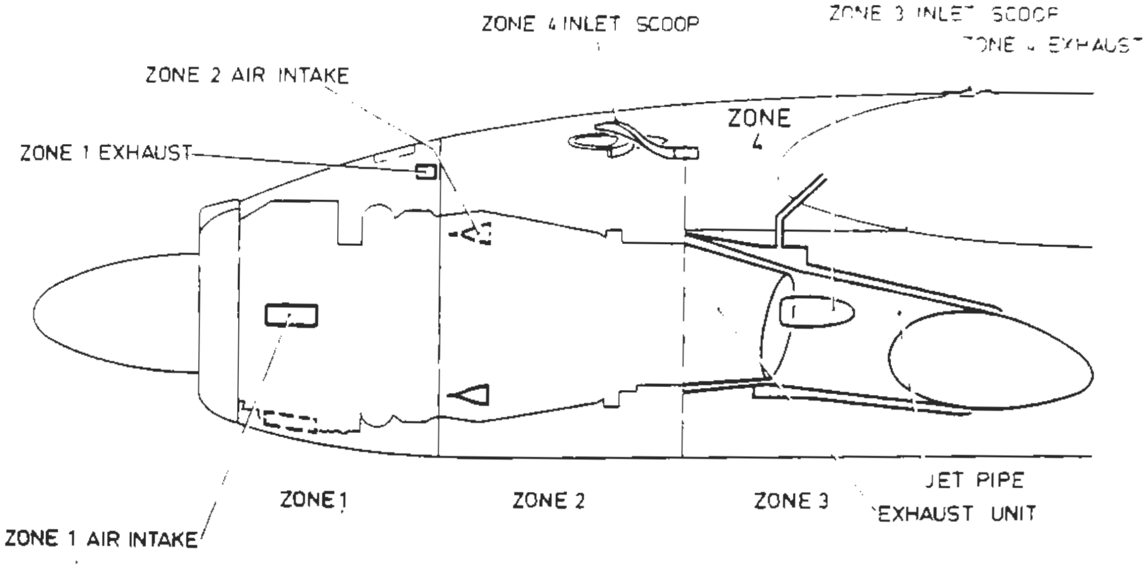
Zone IV is the gearbox compartment.
This zone is ventilated by an inlet duct, located on the top cowling panel and connected to an opening in the aircraft fire wall by quick release latches.
(This air duct also supplies air to the pneumatic compressor).
The ventilating air then escapes through an opening at the rear
The ventilating air then escapes through an opening at the rear
of the gearbox compartment top panel.
The supply of cooling air for the generator is taken from the air intake situated in the centre wing leading edge and is ducted to the electrical equipment.
The supply of cooling air for the alternator is taken from the compartment ventilation air, the flow through the alternator is created by a fan in the alternator.
After passing round the equipment the air of the genrerator and alternator is exhausted via metal ducts which protrude into the air outlet opening at the rear of the gearbox compartment top panel.
An auxiliary valve is fitted in the cooling air duct to the generator to provide an alternative air supply from the gearbox compartment should the leading edge air intake ice up.
The remainder of the nacelle, aft of the zone III is ventilated from an air scoop located on the inboard side of the nacelle.

An additional air intake in the top engine cowling supplies cooling air to the accessory gearbox drive shaft.

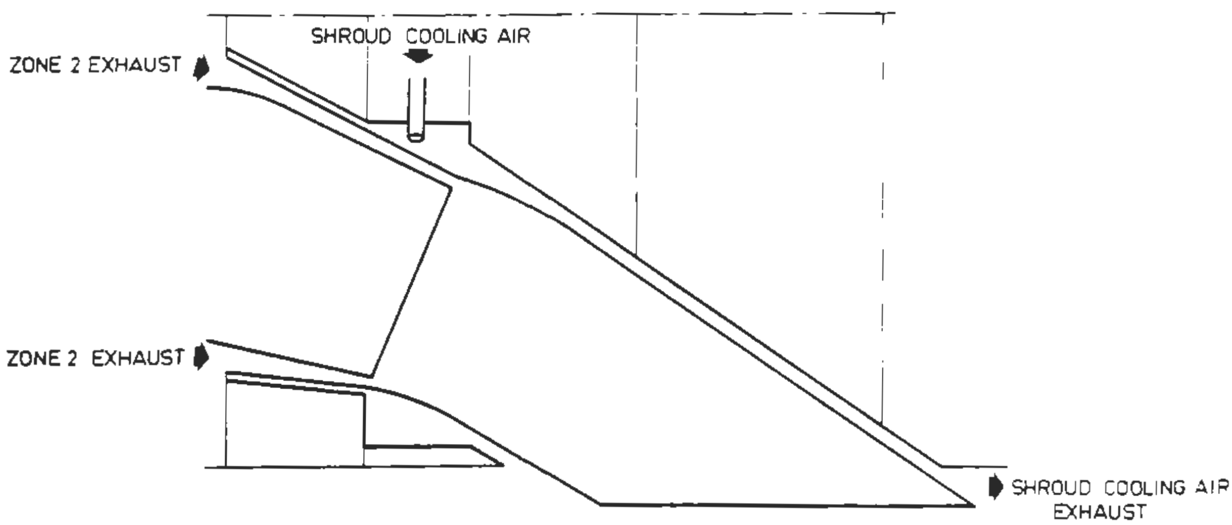
END



POWERPLANT VENTILATION - GENERAL VIEW



ZONE VENTILATION DIAGRAM



EXHAUST UNIT VENTILATION DIAGRAM

POWERPLANT VENTILATION - SCHEMATIC DIAGRAM

76. POWER PLANT CONTROLS

00.0 GENERAL

The power plant control systems described in this chapter are:

a. The power lever control system (also called rpm control system)
b. The HPC control system (HIGH PRESSURE cock)
c. The fuel trimmer control system
d. The propeller synchronizing system.

The power lever control and the HPC control systems are mechanically controlled and operated by handles.

The fuel trimmer and the engine synchronizing systems are electrically controlled by switches.

The handles as well as the switches are located on the pedestal.

Access to the control mechanisms is gained by removing access panels incorporated in the side walls of the pedestal.

10.0 POWER LEVER CONTROL SYSTEM

The power lever control system is mechanically operated by power levers on the pedestal quadrant in the cockpit. A cable system is used between the pedestal and an end pulley assembly on the rear of the fire wall. Control motion is then transmitted to a control box mounted on the engine, by a system of push-pull rods, bell cranks and a control box located on the front side of the fire wall. The control box allows gas tight control movement through the fire wall. From the engine control box to the engine mounted control units, control is by means of push-pull rods, cross-shafts and bell cranks attached to the engine structure.

Provisions are incorporated for the selection of propeller ground fine by means of either power lever. This is accomplished by lifting and retarding the lever beyond the idling position, thereby disengaging the lever from its control system.

Friction mechanisms are incorporated to prevent creeping of the controls during engine operation, and to prevent feedback of corrector motor movement when an engine synchronizing system is installed.

A power lever control locking system, installed in the pedestal operates in conjunction with the gustlock system. A manual selector knob on the pedestal allows either engine to be operated at maximum power while the other power lever is retarded.

10.1 Power Levers

Two power levers one for each engine, are centrally installed on a transverse shaft in the pedestal in order to enable dual operation. Each lever is engaged with an operating segment by means of a cam riveted to the segment. Disengagement of the lever between idle and maximum rpm positions is prevented by a guide pin fitted to the lever and a stationary segment. The stationary flanged segment is fitted to the transverse shaft and locked against rotation by a spring-loaded shaft, located just forward of

the transverse shaft. With the lever in the idle position the guide pin is just clear of the stationary flanged segment but disengagement is prevented by a spring-loaded lever fitted to the operating segment. Each operating segment drives a cam shaft which in turn drives a cable pulley to which the cable is anchored. An end stop unit on the cam shaft is provided with adjustable stops, serving as secondary stops for idling and take-off rpm.

Each cam shaft actuates a set of four microswitches for sequencing of electrical power supply for operation of various components at different power lever handle settings. A manual operated friction mechanism is incorporated to prevent creeping of the levers. It consists of a brake pad which is pressed against the operating segments of both levers. Friction can be adjusted by means of a knob.

10.2 Power Lever Control Lock

To prevent a take-off with the flight controls locked a power lever control locking mechanism is installed in the pedestal preventing the levers to be moved to the maximum rpm position simultaneously with the gustlock engaged, yet allowing sufficient power for taxiing. The mechanism is connected to the gustlock handle by a Teleflex cable. It consists of two spring-loaded catches which (one at a time) engage with cams on the power lever at approximately 12,000 rpm with the gustlock handle placed in the LOCKED position. To operate an engine above 12,000 rpm with the flight controls locked, a selector mechanism is incorporated which allows unlocking of either the left-hand or right-hand power lever The mechanism is designed so that if either lever is advanced above 12,000 rpm it must be retarded before the other engine can be selected. The mechanism consists of a spring-loaded selector, a link, and an interlock unit provided with a rear lever and a front lever. When either the left-hand or right-hand engine is selected with both levers in the IDLE position, the rear lever keeps the appropriate catch down, thereby unlocking the appropriate handle. If, however, a lever is advanced above 12,000 rpm no selection can be made as the front lever is abutting the underside of the cam on the handle.

10.3 Normal Operation

To facilitate operation of the engine each power lever is mechanically connected to the fuel control unit, the propeller control unit and the water/methanol control unit. Movement of the power lever positions the throttle lever of the fuel flow control unit and the governor lever of the propeller control unit in the proper ratio as to fuel flow and rpm. In principle, forward movement of the power lever increases and changes governor setting.

The water/methanol control unit is effected by the power lever when the lever is advanced to maximum power less 300 rpm. This admits oil pressure to the servo in the water/methanol control unit, thus allowing water/methanol to be metered to the engine in accordance with torque pressure and ambient pressure.

In addition to the preceding mechanical function each power lever actuates a set of four microswitches which have a function in other aircraft systems. The actuating cams are set to operate the switches at various power lever settings and are color coded and numbered for easy identification as follows:

Switch No.	Color Code	Function
1	Black	Opens the spill valve above 14,400 rpm (RDa 6 only)
2	White	Arms landing gear warning horn circuit when below 10,500 rpm.
3	Green	Arms automatic feathering circuit and provides testing of the power unit de-icing system at full alternator output above 11,500 rpm (Pre SB 61-25) or 12,800 rpm (Post SB 61-25).
4	Blue	Arms ground fine pitch circuit below 14,000 rpm. R.H. m.s. also used in the prop. G.F.P. warning system.
5	Red	No function

10.4 Ground Fine Selection

When one of the power levers is in the IDLE position, ground fine can be selected by lifting the lever and moving it backwards beyond the IDLE position. This movement actuates two microswitches located in the front of the pedestal completing the circuit to the ground fine stop.

With the lever in the IDLE position the guide pin is just clear of the flanged stationary segment making it possible to lift the lever approximately one inch against the action of a spring-loaded lever, allowing the guide pin to slide through a gap between two guides on the operating segment. When the lever is lifted, it is disengaged from the cam and an additional 13 degrees of travel is available beyond the IDLE position without altering the position of the operating segment and that of the power lever During the movement of the handle the guide pin is used as a pivot point. At the end of its travel a pin on the lever operates the spring-loaded shaft causing the cams on the end of the shaft to actuate two micro-switches incorporated into the ground fine circuit. When the power lever is released it will automatically return into the IDLE position by the action of the spring-loaded lever and shaft.

END

11.0 HPC CONTROL SYSTEM

The high pressure cock (HPC) and feathering controls on each engine are mechanically operated by a control handle on the pedestal. A cable system is used between the pedestal and an end pulley assembly on the rear of the fire wall. Control motion is then transmitted to the engine-mounted control box by a system of push-pull rods and the control box on the front side of the fire wall. From the engine control box to the engine-mounted control units, control is by means of push-pull rods, cross-shafts and bellcranks attached to the engine structure.

11.1 Control Levers

The control levers are installed on a transverse shaft in the pedestal. By means of an adjustable push-pull rod each lever is directly connected to an end pulley mounted on the HPC - Power Lever end pulley shaft in the pedestal. The control levers may be set in either the OPEN, SHUT or FEATHER position. Each lever is hinged in slots incorporating a gate between the SHUT and FEATHER position. To proceed from SHUT to FEATHER it is necessary to pull the levers inboard. This operation does not affect the closed position of the high pressure fuel cock. The control levers may be set in a fourth position placarded LOCK-OUT. This position, located beyond the OPEN position is used for manual removal of the cruise lock.

To prevent an engine flame-out caused by the levers inadvertently overrunning the open position when retarded from LOCK-OUT, safety devices are provided to arrest the levers in the OPEN position. Each safety device consists of a camplate and a spring-loaded lever fitted to a bracket on the front wall of the pedestal. An adjustable push-pull rod connects the camplate to a lever riveted to the appropriate end pulley on the HPC - Power Lever end pulley shaft. With the HPC lever in the OPEN position a roller fitted to the spring-loaded lever engages with a recess in the camplate, thus arresting the lever in that position.

The HPC end pulleys in the pedestal are provided with adjustable cams which actuate microswitches incorporated in the propeller circuit. The microswitches with their actuators are mounted to brackets, bolted to the pedestal frame. Slotted holes in the brackets allow adjustment of the switches.

11.2 Operation

To facilitate operation of the engine, each HPC control system is mechanically connected to the high pressure fuel lever on the fuel flow control unit and to the feathering selector lever on the propeller control unit. The interconnection between the HPC controls and the feathering controls on the engine is fully described in the applicable Rolls-Royce Maintenance Manual.
With the HPC levers in the OPEN position, the high pressure fuel valves are open thus permitting high pressure fuel to pass into the combustion chambers. The cam operating the HPC switches closes the microswitch "B" to arm the automatic feathering circuit. When the HPC levers are moved to LOCK-OUT the feathering selector lever on the propeller control unit is moved to LOCK-OUT permitting the propeller cruise lock to be removed. Toggling action of the linkage on the engine and dead movement of the high pressure fuel valve results in the high pressure valve remaining open. Movement of the HPC levers to the closed position closes the high pressure valve and rotates the HPC operating cam to disarm the automatic feathering circuit by opening the microswitch "B". When the HPC levers are moved to "FEATHER" the piston valve in the propeller control unit is lifted thus permitting the propeller to be feathered. At the same time the cam operating the HPC switches changes over the rearward microswitch "A" to energize

the respective isolating relay and the piston valve lift solenoid. Movement of the handles from SHUT to FEATHER does not affect the closed position of the high pressure fuel cock.

NOTE: Completion of feathering by means of the feathering pump may be necessary, depending on the oil pressure generated by the engine as it slows down.

11.3 Microswitches

The microswitches operated by the cam on the HPC end pulley in the pedestal are designated M.S. "A" and M.S. "B".

The rearward switch, M.S. "A", changes over its contacts whenever the HPC lever is moved to the FEATHER position. In this position, the isolating relay in the propeller electrical circuit is continuously energized.

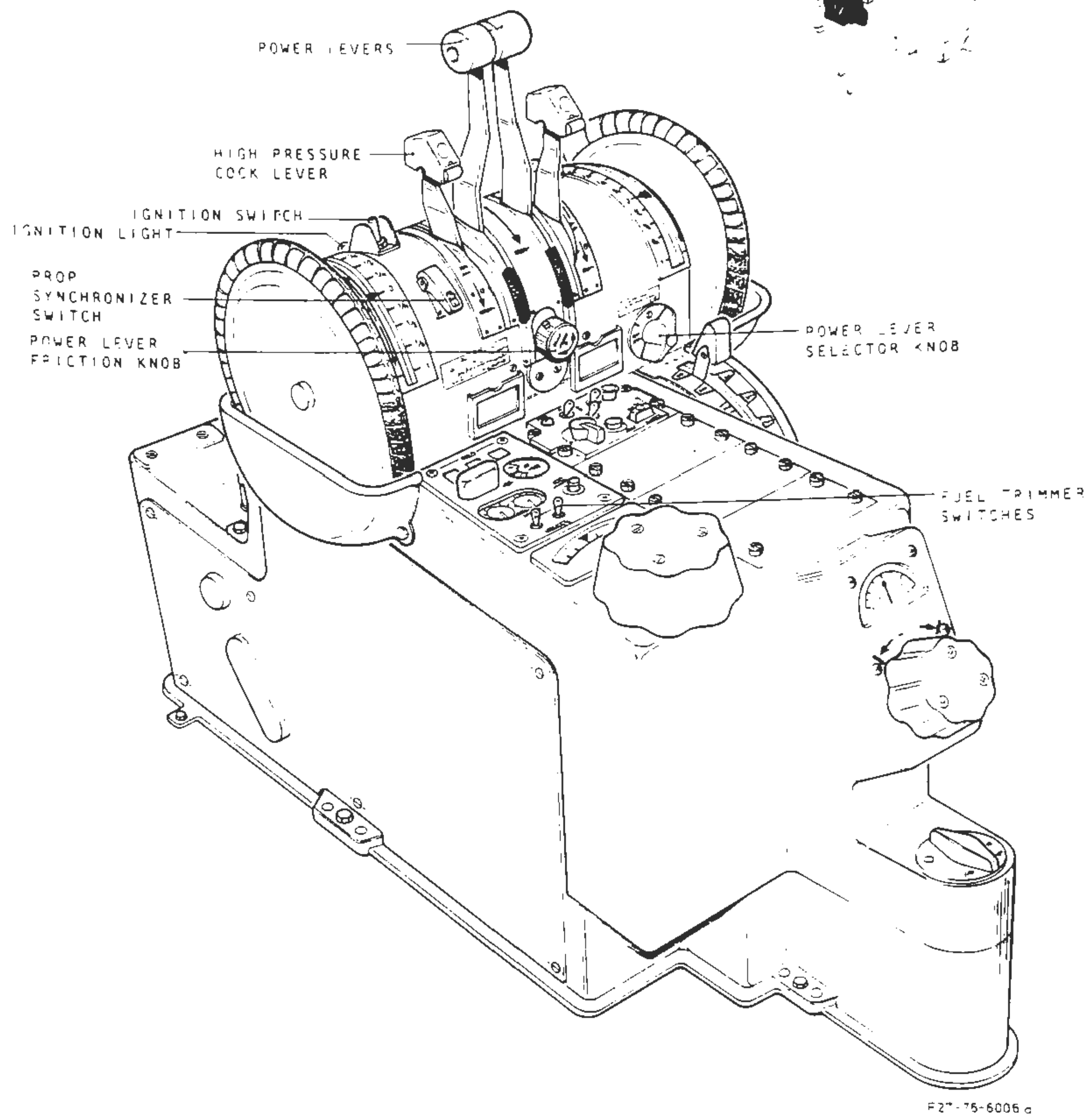
This isolating relay, when energized:

- Prevents the other engine from auto-feathering.
- Stops the Water/Methanol supply to the feathered engine.
- Opens the spill valve between the cabin blower of the feathered engine and the cabin to prevent fumes and toxic gases from entering the cabin in the case of an engine fire and use of the engine fire extinguishing system.
- Operates the warning light dimming facilities.
- Energizes the piston valve lift solenoid.

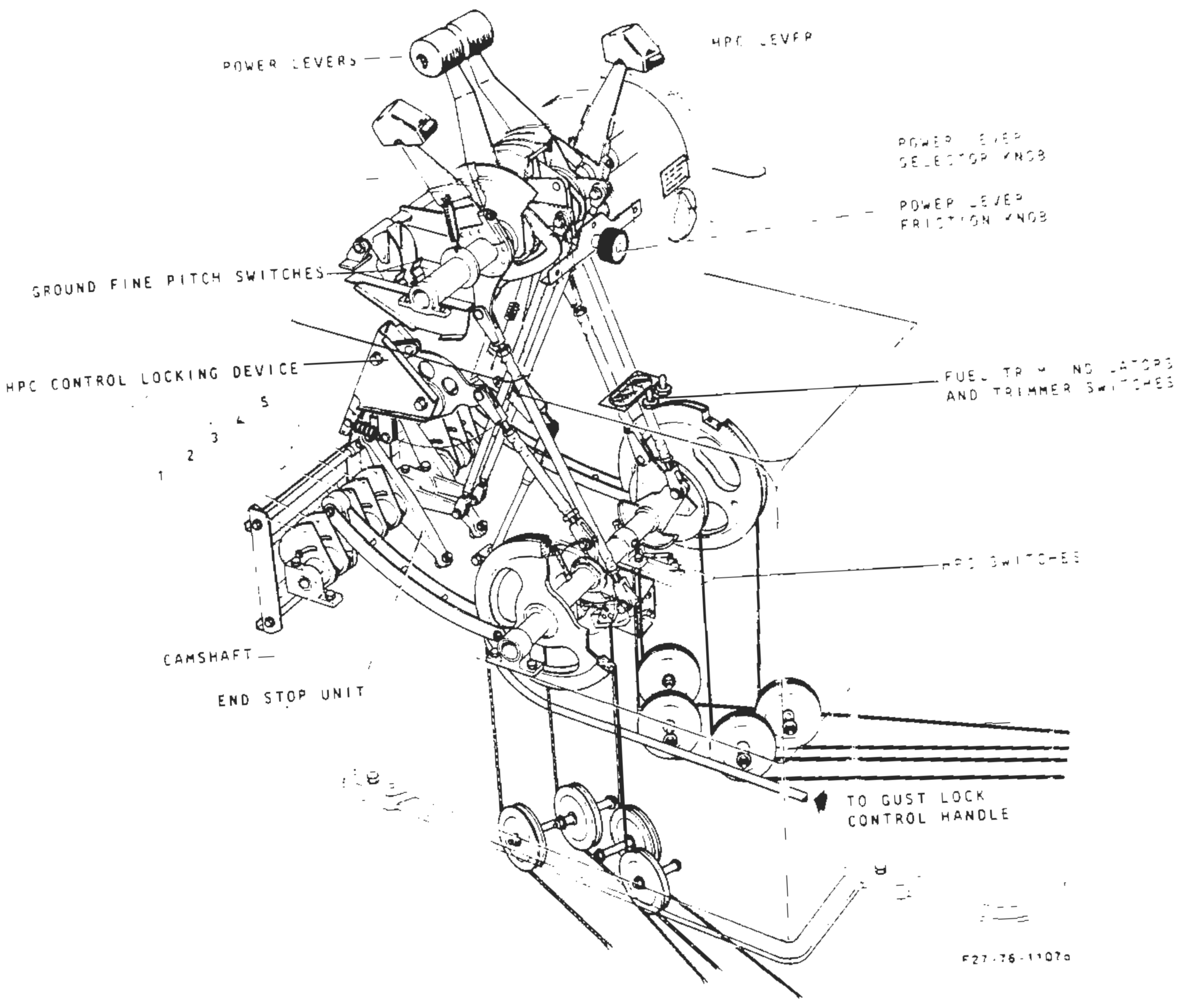
M.S. "B" is the forward switch and is closed with the HPC lever in the OPEN position and the LOCK-OUT position if applicable.

This switch when closed arms the propeller auto-feathering circuit.

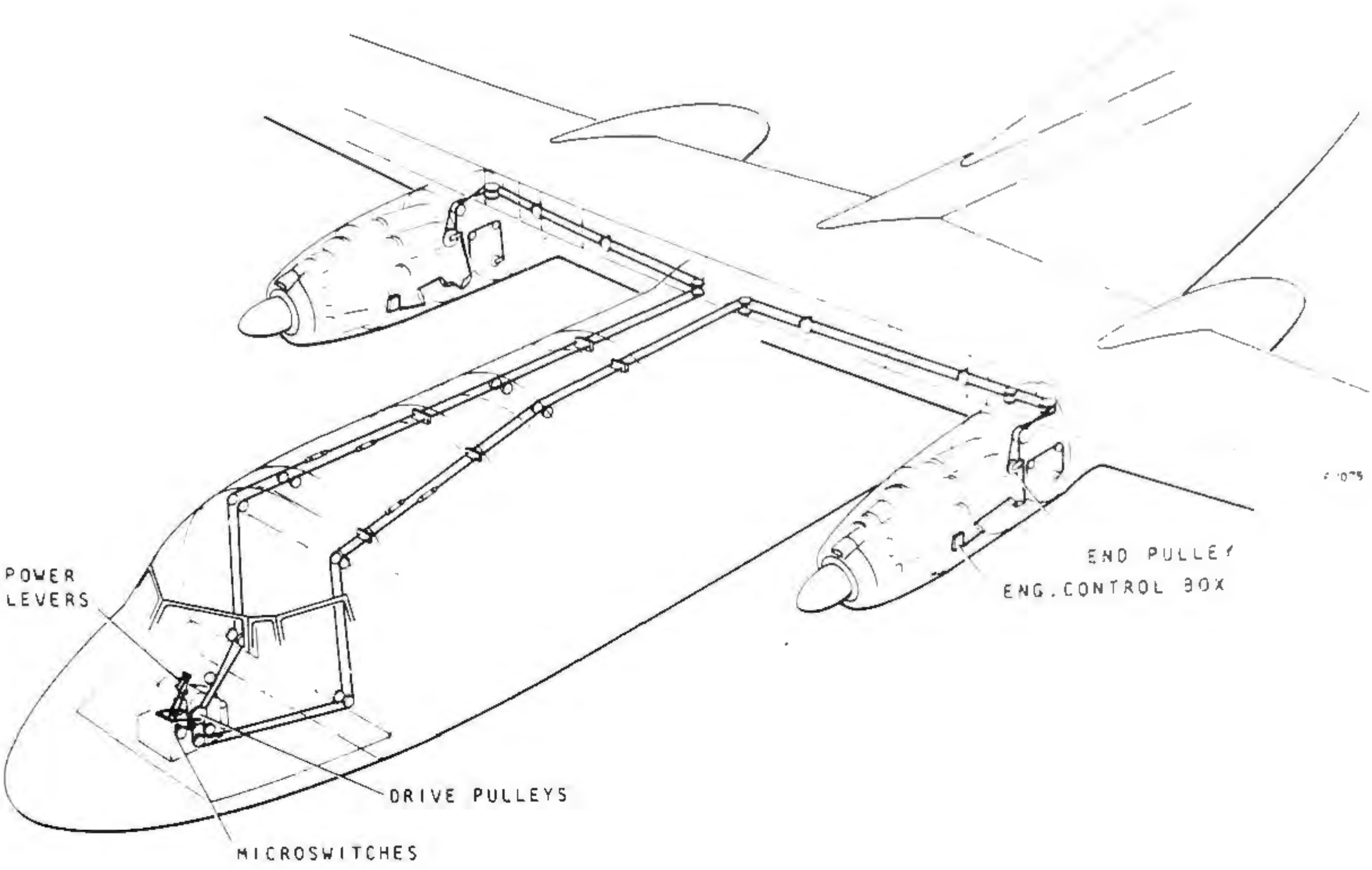
END

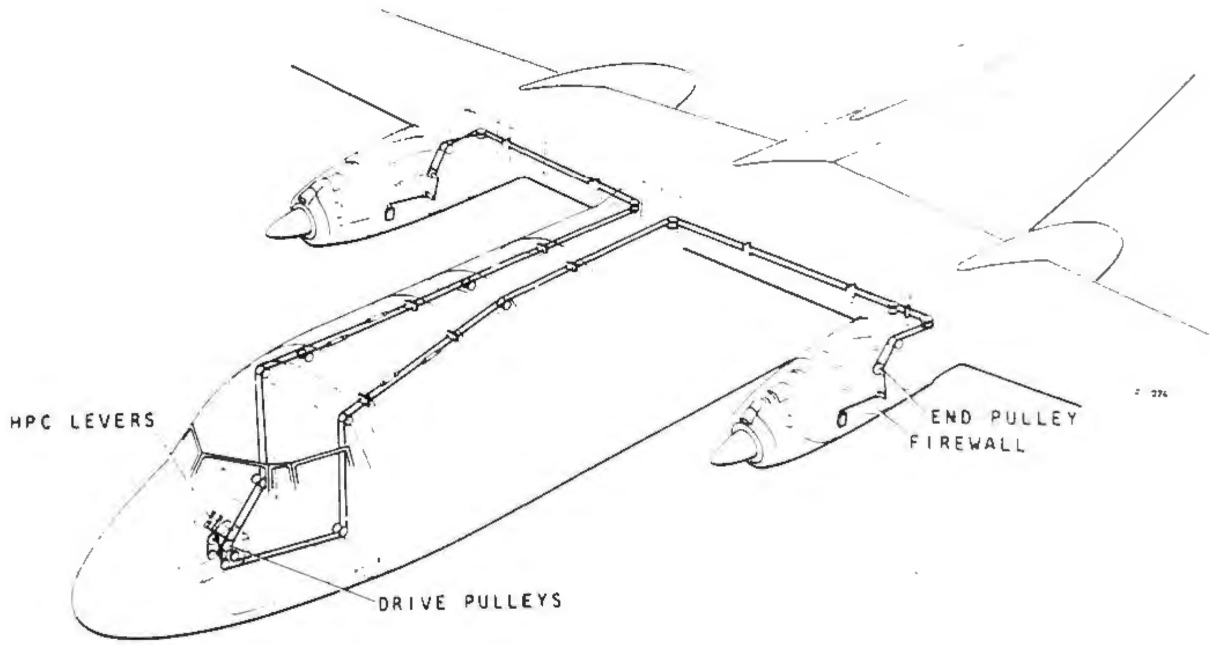


POWER PLANT CONTROLS ON PEDESTAL

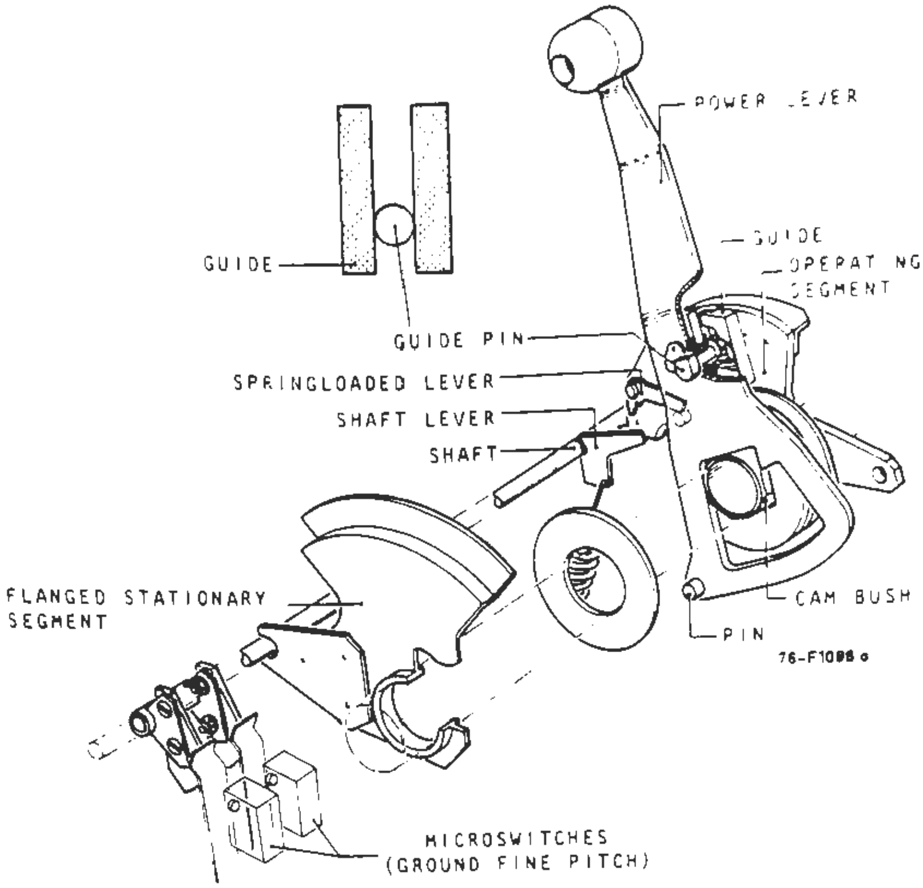


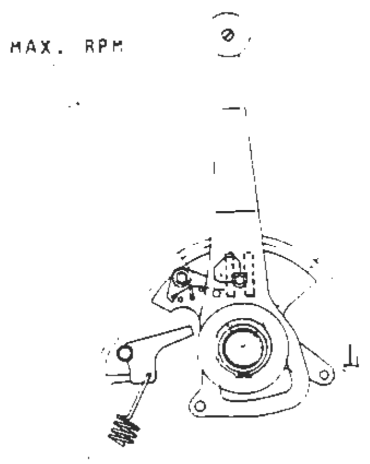
POWERPLANT CONTROL MECHANISM IN PEDESTAL

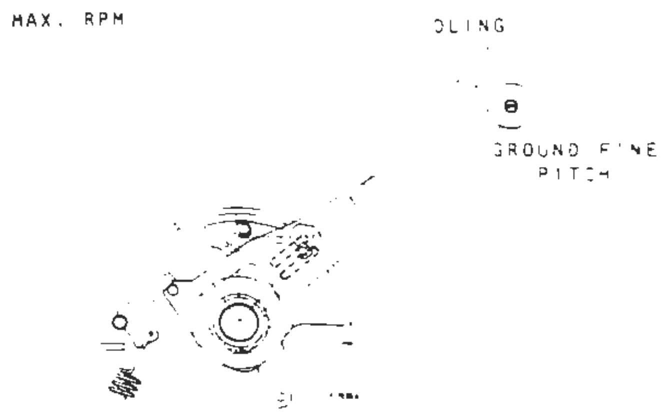




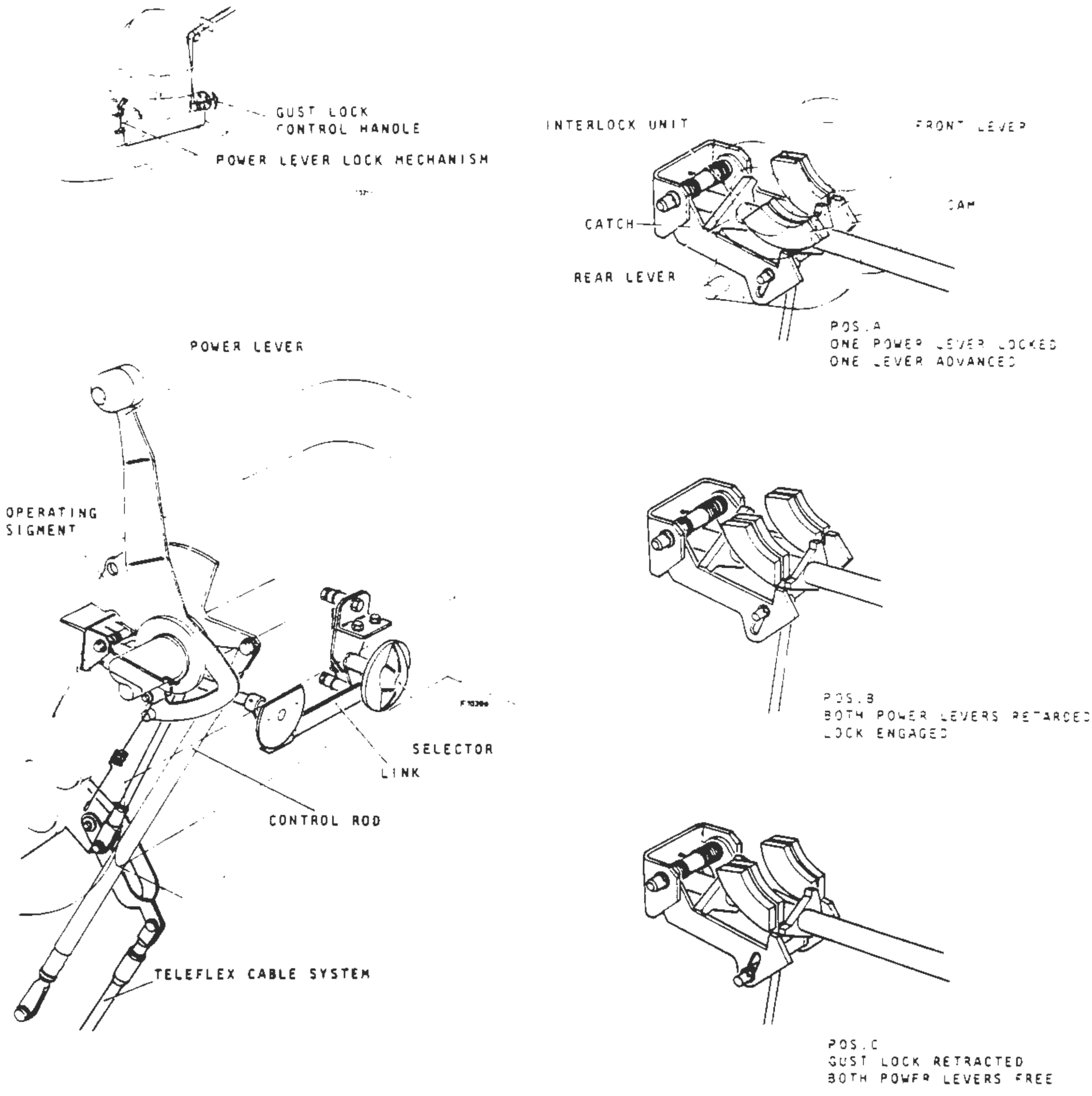
POWER LEVER CONTROL SYSTEM AND HPC CONTROL SYSTEM



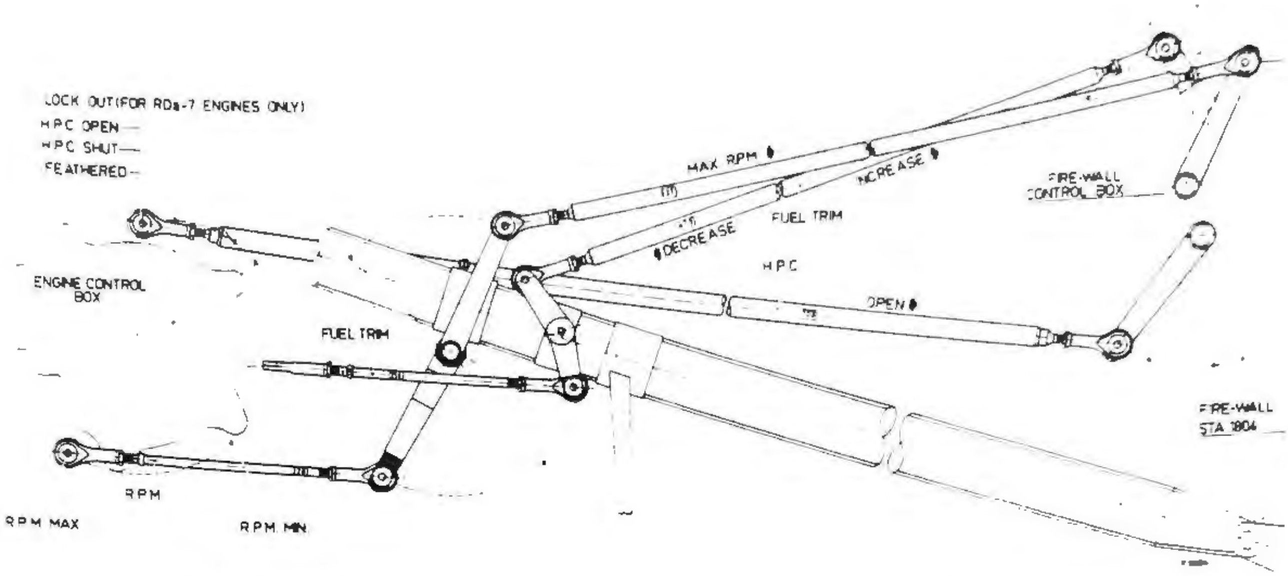




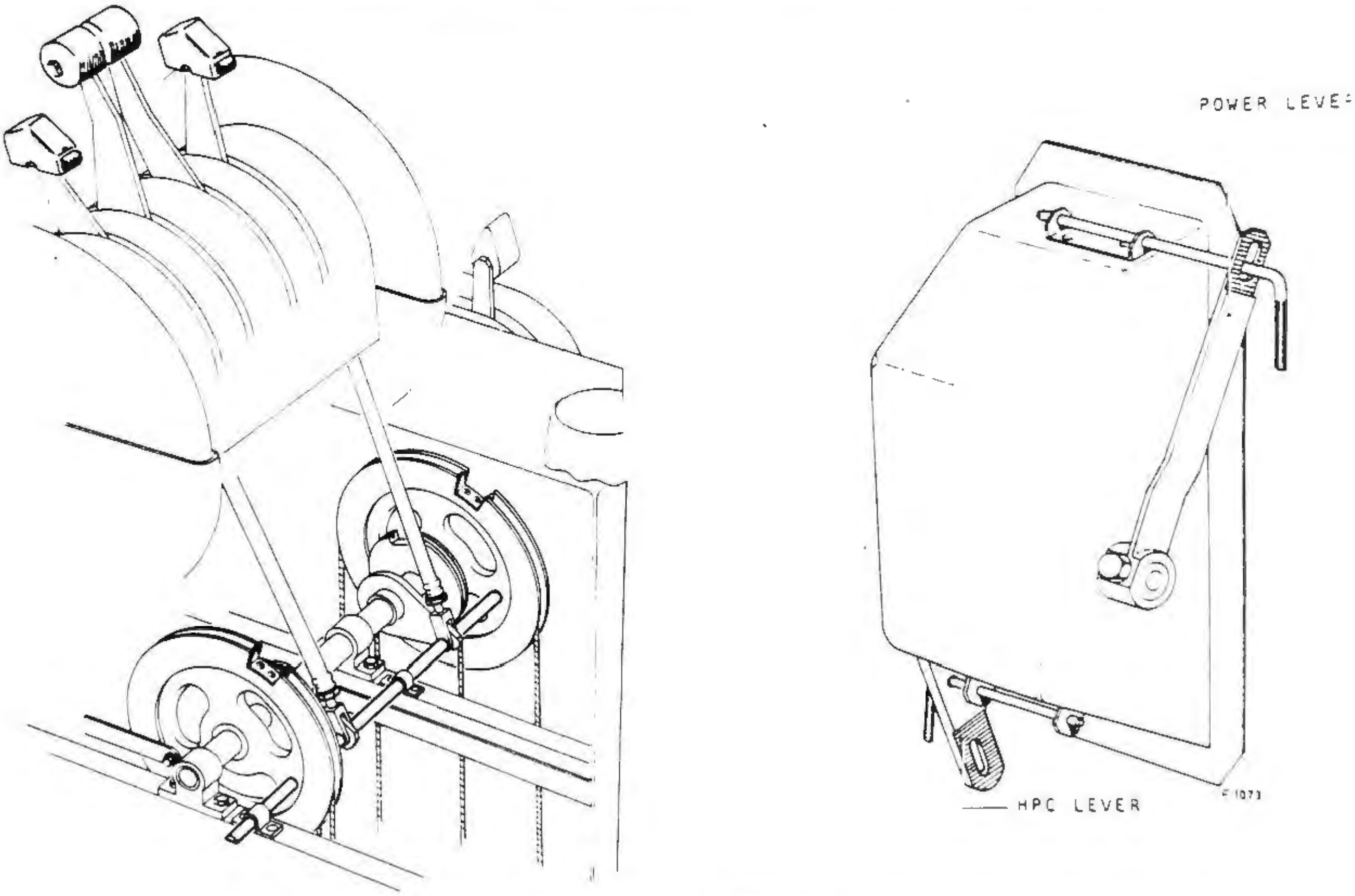
DETAILS OF POWER LEVER



POWER LEVER CONTROL LOCK



ENGINE CONTROLS BETWEEN FIREWALL AND ENGINE CONTROL BOX



LOCKING OF POWERPLANT CONTROLS IN PEDESTAL AND AT THE FIREWALL

12.0 FUEL TRIMMER CONTROL SYSTEM

Should the air mass flow be reduced by a higher-than-standard outside air temperature than the fuel trimmer enables the fuel to be reduced for the whole engine rpm range to prevent overheating above the desired operating temperature.

A fuel datum computer is used in conjunction with the fuel trimmer system. It is installed on the overhead panel and is used to determine the amount of trim correction required for a given engine, according to the data card for that particular engine.

12.1 Operation

A linear actuator is installed in each nacelle to the rear of the aircraft fire wall.
Each actuator is operated by a control switch on the cockpit pedestal.
The actuator consists of a split-field, fractional horse-power, DC motor which drives a screw-jack through a reduction gear.
The screw-jack is threaded into a plunger which is restricted to a linear motion by the plunger housing.
TWo internal limit-switches, operated by lugs on the plunger, interrupt the motor circuit when the actuator plunger reaches its fully retracted or fully extended position.
Overrun is minimized by an electro-magnetic brake incorporated in the actuator and also the actuating plunger is provided with a spring-loaded end-fitting which connects to the lever on the upper shaft of the fire wall control box.
From the upper shaft in the fire wall control box, actuator movement is transmitted to the trimmer pick-up lever on the engine control box by means of push-pull rods and a bellcrank attached to a bracket on one of the engine mounting struts.

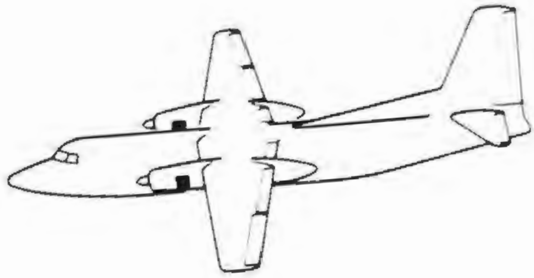
12.2 Fuel Trimmer Position Indication

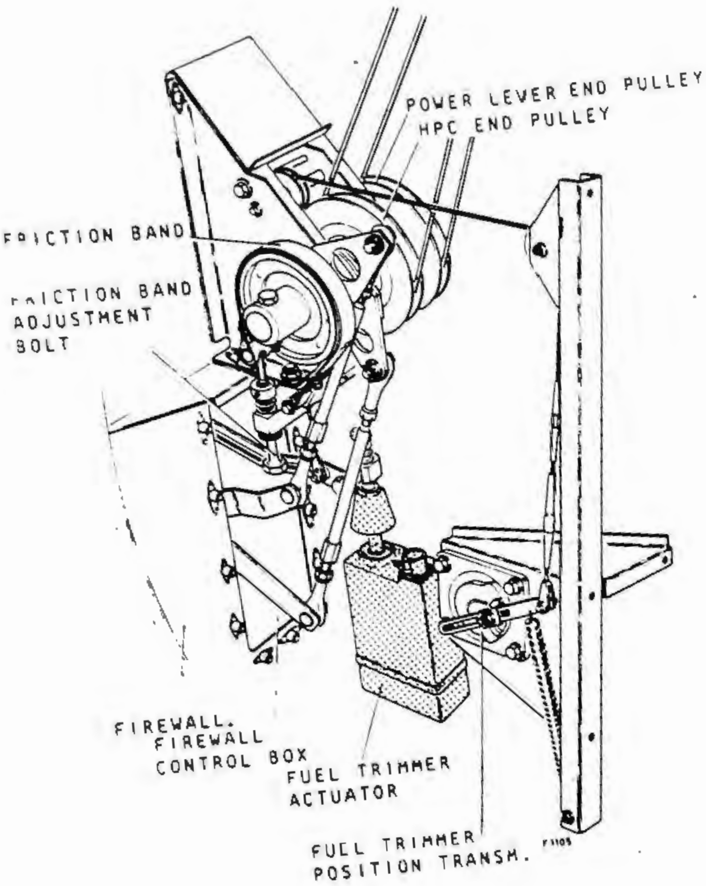
A position transmitter, mounted on a bracket and located in the nacelle, is operated by means of a cable system routed via two cable pulleys.

One end of the cable is attached to the lever on the fire wall control box upper shaft and the other end to the transmitter operating lever.

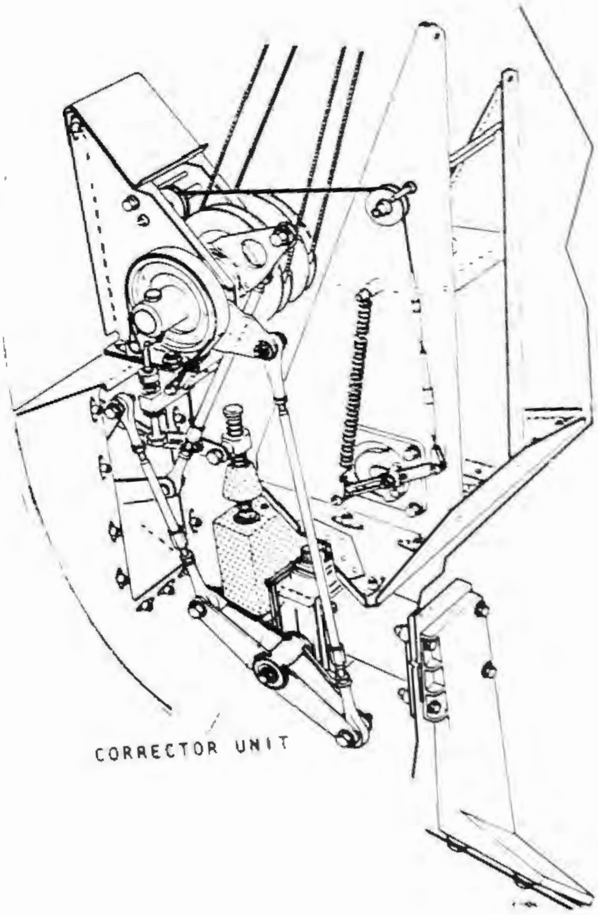
A tension spring, acting on the transmitter operating lever keeps the cable tight by loading the transmitter lever to the "decrease" position.

END



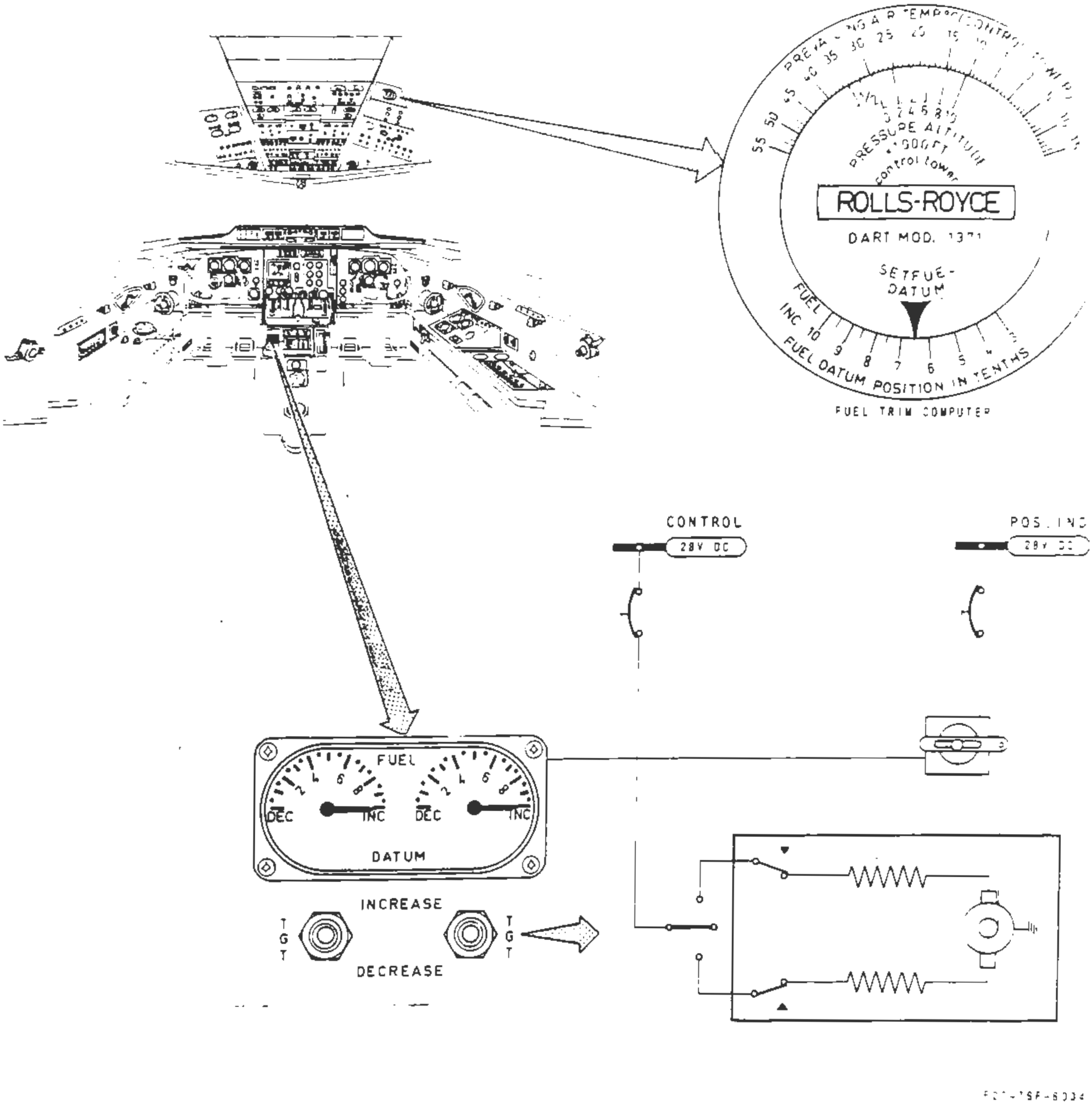


LH NACELLE



RH NACELLE

POWERPLANT CONTROL MECHANISM IN NACELLE



FUEL TRIMMER

13.0 PROPELLER SYNCHRONIZING SYSTEM

Automatic propeller synchronizing is a system whereby the power lever of a slave engine is brought into synchronism with a master engine. This is to ensure that the engines run at the same speed, minimizing propeller vibration. The automatic synchronizing system consists basically of two synchronizing alternators; one driven by the gearbox of each engine, a corrector unit on the RH engine's power lever linkage and an ON-OFF switch on the pedestal.

The corrector unit compares the output of each alternator and adjusts the RH engine power lever linkage to compensate for differences between the rpm of the engines. The LH engine is considered as the master, the RH engine as the slave engine. Depending on system friction, stiffness of the linkage and rigidity of the linkage fulcrums, very close matching of speeds is possible.

3.1 System Description

The gearbox of each engine is fitted with a synchronizing alternator. These units are three-phase permanent magnet alternators, very similar to tachometer generators only somewhat larger. The output of each alternator is fed into a corrector unit, which is fitted on a bulkhead in the RH nacelle adjacent to the fire wall control box.

The corrector unit compares the two signals and if there is any difference in frequency of the two signals, it converts this difference into a mechanical movement. The output shaft of the corrector unit terminates in a flange incorporating an eccentric spigot. This spigot receives a free-floating bellcrank, which is a part of the power lever linkage, interposed between the controls behind the fire wall. On rotation of the output shaft the eccentricity of the spigot imparts linear movement to the controls, resulting in a change of engine rpm. The output shaft together with the spigot may rotate in either direction from the mid or "datum" position; one direction results in an increase in rpm and the reverse direction a decrease in rpm of the slave engine.

A friction drum, which is a part of the power lever linkage ensures that the motion of the corrector unit is transmitted forward to the engine and not back to the pedestal.

When the equipment is brought into operation, the speed of the slave engine must not differ from that of the master engine in excess of half the rpm control range for synchronization to be achieved.

The total control range for RDa-6 engines is 600 ± 150 rpm whilst RDa-7 engine it is 850 ± 150 rpm.

The slave engine is permitted to vary in speed either side of the nominal speed (corrector unit on datum) up to an amount equal to half the control range. The control range is deliberately restricted by limit stops, so that a failure of the master engine will not cause too great a drop in rpm of the slave engine. A slip clutch is incorporated to protect the mechanism of the corrector unit when it reaches the limit stops.

The engine settings may be changed in the normal manner since the eccentric spigot on the corrector unit serves as a fulcrum for the controls during normal operation.

13.2 Principle of Operation

The operation of the system is based on the principle that, when a three-phase induction motor is connected to an alternator and with the phases in similar sequence, the motor will rotate in the same direction and at a speed close to that of the alternator. The corrector unit can be regarded as two separate three-phase induction motors, one above the other, with a common rotor driving the output shaft. Each motor stator has impressed on it the output frequency of one alternator exerting an opposing torque on the common rotor.

When the system is switched on, the top stator is supplied by the slave engine alternator and the bottom stator by the master engine alternator. The phase rotation is such that the signal to the slave stator will rotate the rotor in a "decrease rpm direction and the signal to the master stator in an "increase rpm direction. Since their torques are opposed then as long as both alternators are running at the same speed (same frequency), their effects will be cancelled out and the rotor with consequently the output shaft, will remain stationary. If, however, one alternator is running faster than the other, the difference in torque will cause the corrector unit to rotate in the direction of the motor receiving the higher frequency.

When the synchronizing system is switched off and before a new synchronization can take place, the output shaft of the corrector unit has to be returned to the mid-travel position. This is achieved by a datum-reset cam in the corrector unit. This cam operates a datum-reset switch as soon as the corrector unit has rotated more than 6.5 degrees either side of the mid-travel position. Putting the system control switch in the OFF position disconnects the master alternator from the corrector unit master stator and connects the slave alternator to the corrector unit slave stator. This causes the corrector unit rotor assembly to return to "datum" by normal phase rotation if it is in the "increase rpm"position and by anti-phase rotation if it is in the "decrease rpm"position.

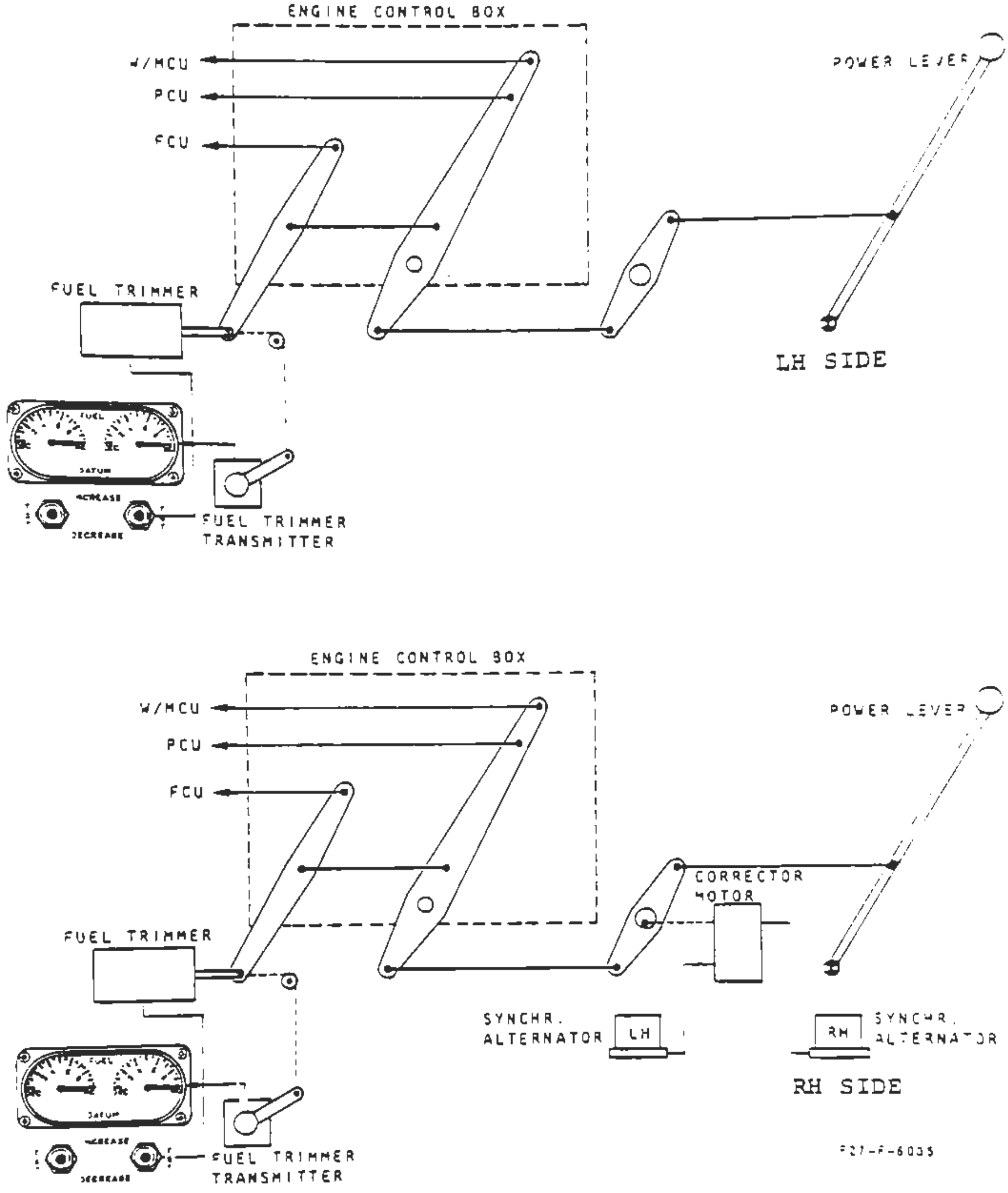
13.3 Operating the System

Since failure of the master engine with this system in operation will drag the slave engine down 300 rpm (425 rpm,RDa-7) and since this condition at a critical time might impair airplane safety, this system should not be used during landing and take-off operations. If, however, the system is left ON accidentally during take-off and a failure of the master engine occurs, the slave engine will be dragged down but the power lever can be pushed fully forward to regain this power loss.

When the slave engine is stopped with the synchronizing system ON and the master engine running, the corrector unit will be driven to the full increase position in an endeavour to keep the rpm the same as the master engine.

Although the power lever of the slave engine was closed upon shut-down, the fuel control unit will be moved forward a small amount. To make sure that the fuel control unit is at its minimum stop before the next start, the power levers should be pulled fully backwards to the idle position.

NOTE: The synchronizing system will only be effective in the constant speed range. The system should therefore be switched off before the power is reduced below the minimum constant speeding rpm.



PROPELLER SYNCHRONIZING SYSTEM

77

ENGINE INDICATING

77. ENGINE INDICATING

00.0 GENERAL

The engine indication and warning system consists of the:

RPM indication system,
TGT indication system,
Oil pressure indication system,
Oil temperature indication system,
Torque pressure indication system,
Low oil pressure warning system.

11.0 RPM INDICATION SYSTEM

This system provides visual indication of engine rpm on the main instrument panel. The indicator consists essentially out of a three-phase motor, running synchronous with the gearbox-driven tacho generator. The motor drives a permanent magnet revolving in a hairspring restrained magnetic drag cup, providing a torque proportional to the speed of the motor.
The main pointer connected to the drag cup gives the tenths information and the sub-dial geared to the main pointer, gives unit information.

12.0 TGT INDICATION SYSTEM

The TGT indicator measures the temperature at the inlet of the I.P.G. vanes through 12 alumel-chromel thermocouples connected in parallel.
The instrument is basically a millivoltmeter and measures the potential difference between the hot junction at the turbine couple and the cold junction in the instrument. A build-in condenser compensates for changes in surrounding temperatures.
The TGT is indicated by a needle on a scale with a range from 0 - 1000° C.

13.0 OIL PRESSURE INDICATION SYSTEM

The oil pressure indication system comprises an oil pressure transmitter, located between the first and second stage of the compressor and an oil pressure indicator located on the main instrument panel.

The AC-ratiometer pressure indicator is used in conjunction with the inductor pressure transmitter and has a range from 0 to 40 psi.

A change in pressure at the transmitter causes a variation in the transmitter output and a corresponding change in reading on the indicator dial, which is calibrated in psi.

14.0 OIL TEMPERATURE INDICATION SYSTEM

The oil temperature indication system comprises an oil temperature indicator, installed on the main instrument panel and an oil temperature bulb positioned in the inlet to the pressure pump.

The indicator is a DC ratiometer and is used in conjunction with the oil temperature bulb to indicate temperature over a range of -50° C. to + 150° C.

The resistance value of the bulb changes with temperature. Variation in oil temperature effects a proportionate change in element resistance. This causes a corresponding change in current in the oil temperature indicator, which reflects as an increased or decreased indicator reading.

15.0 TORQUE PRESSURE INDICATION SYSTEM

The torque pressure indication system comprises a torque pressure indicator, installed on the main instrument panel and a torque pressure transmitter located on the left-hand side of the air intake casing

The indicator is a DC ratio indicator and is used in conjunction with the torque pressure transmitter, to indicate torque pressure over a range of 0 to 600 psi.

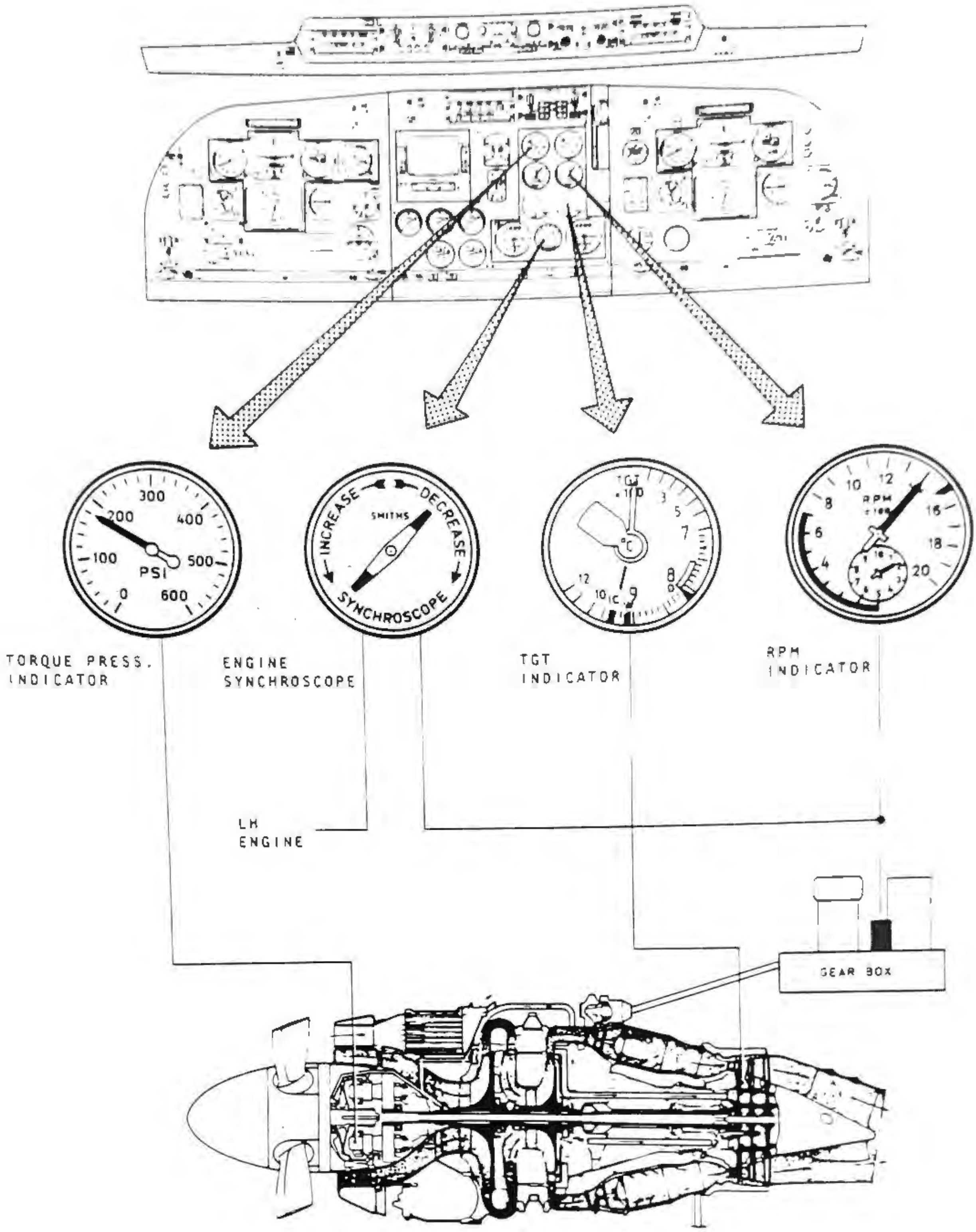
A change in torque pressure at the transmitter causes a variation in the transmitter output and a corresponding change in the reading on the indicator dial, which is calibrated in psi.

16.0 LOW OIL PRESSURE WARNING

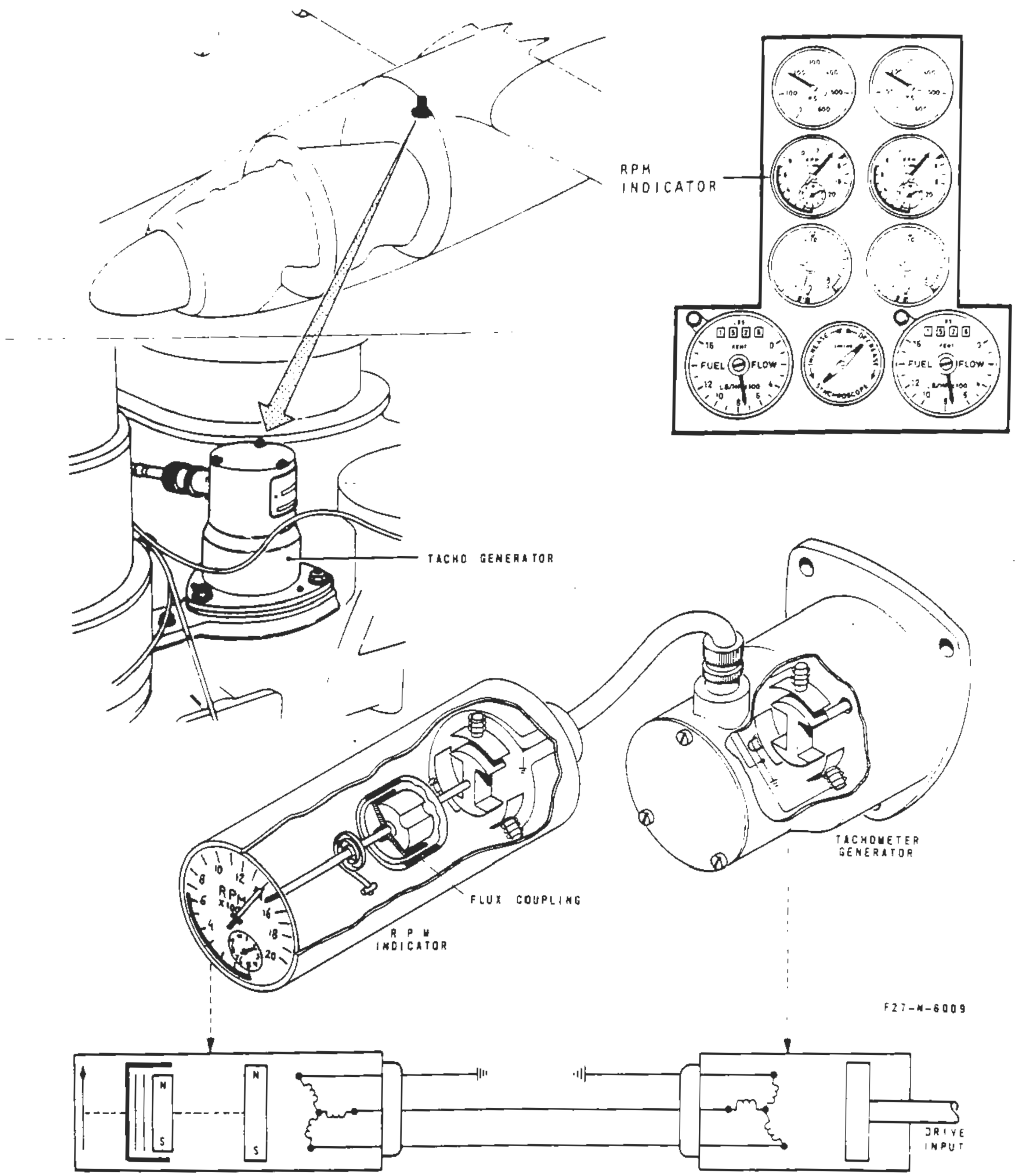
The low oil pressure warning system comprises a master warning light and a low pressure warning light, located on the main instrument panel and a low oil pressure warning switch, installed on the oil pressure transmitter.

When the oil pressure drops below 5 to 6 psi the contact of the low oil pressure warning switch will close, causing illumination of the master warning light and the low oil pressure warning light.

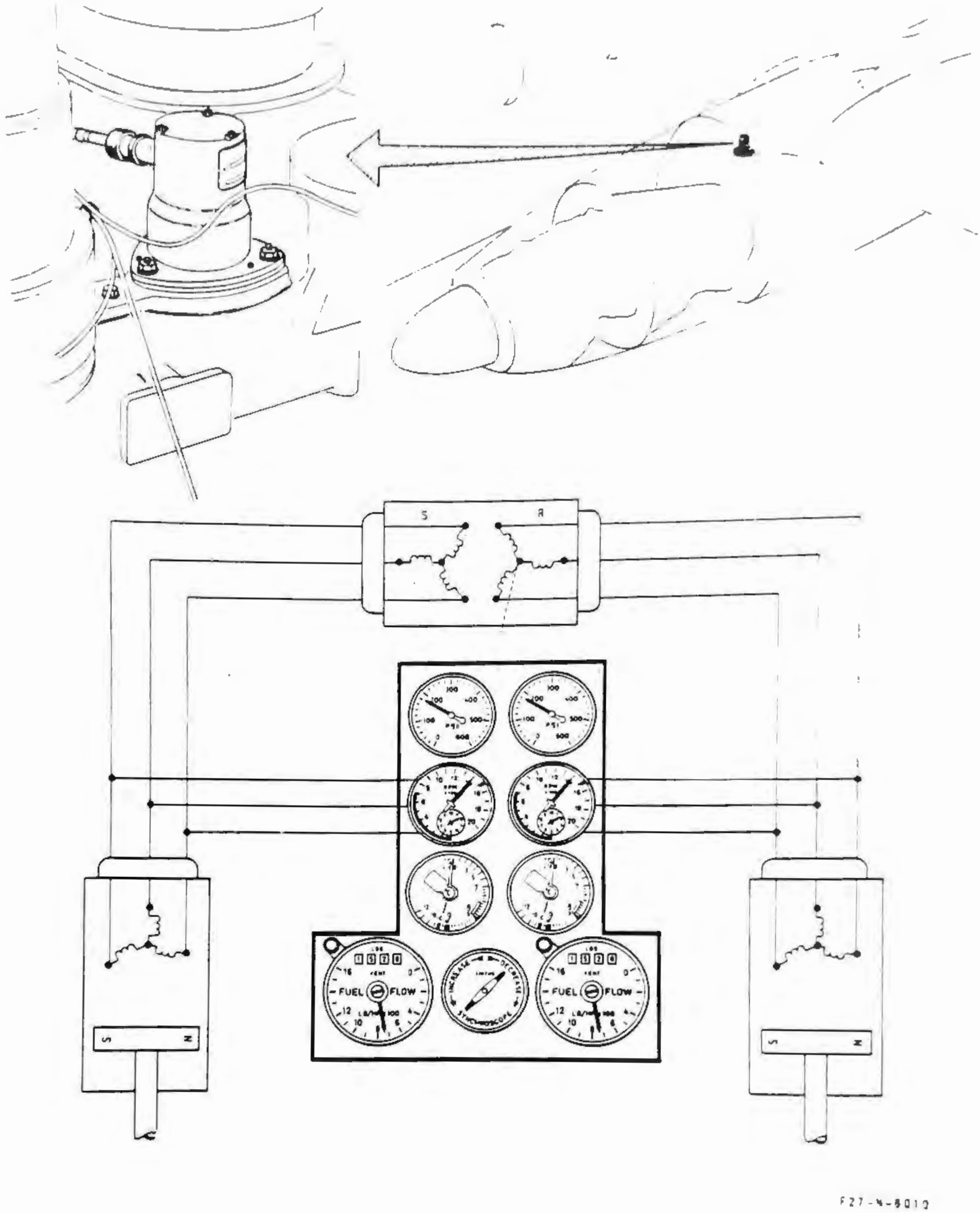
END



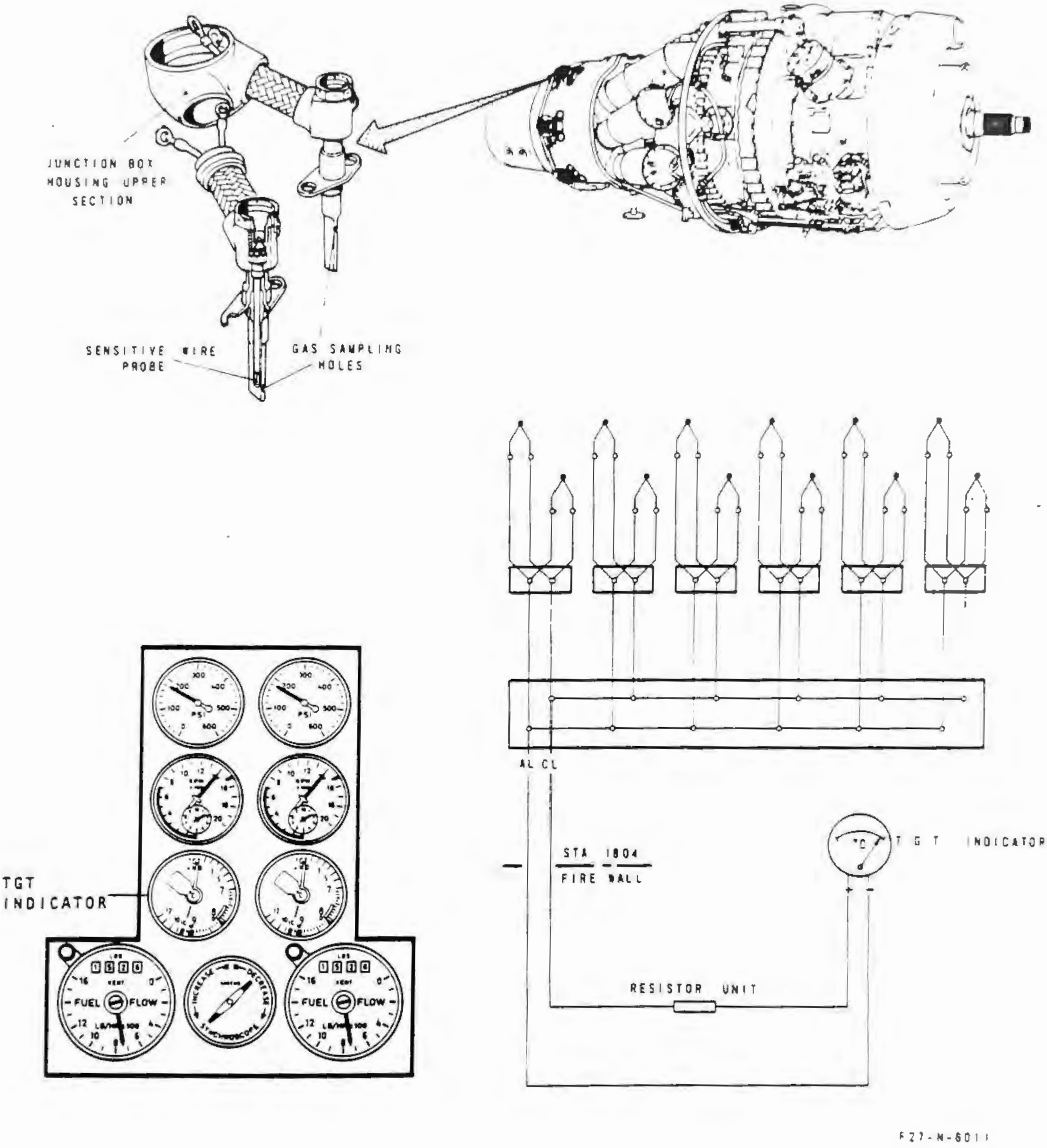
ENGINE POWER INDICATION



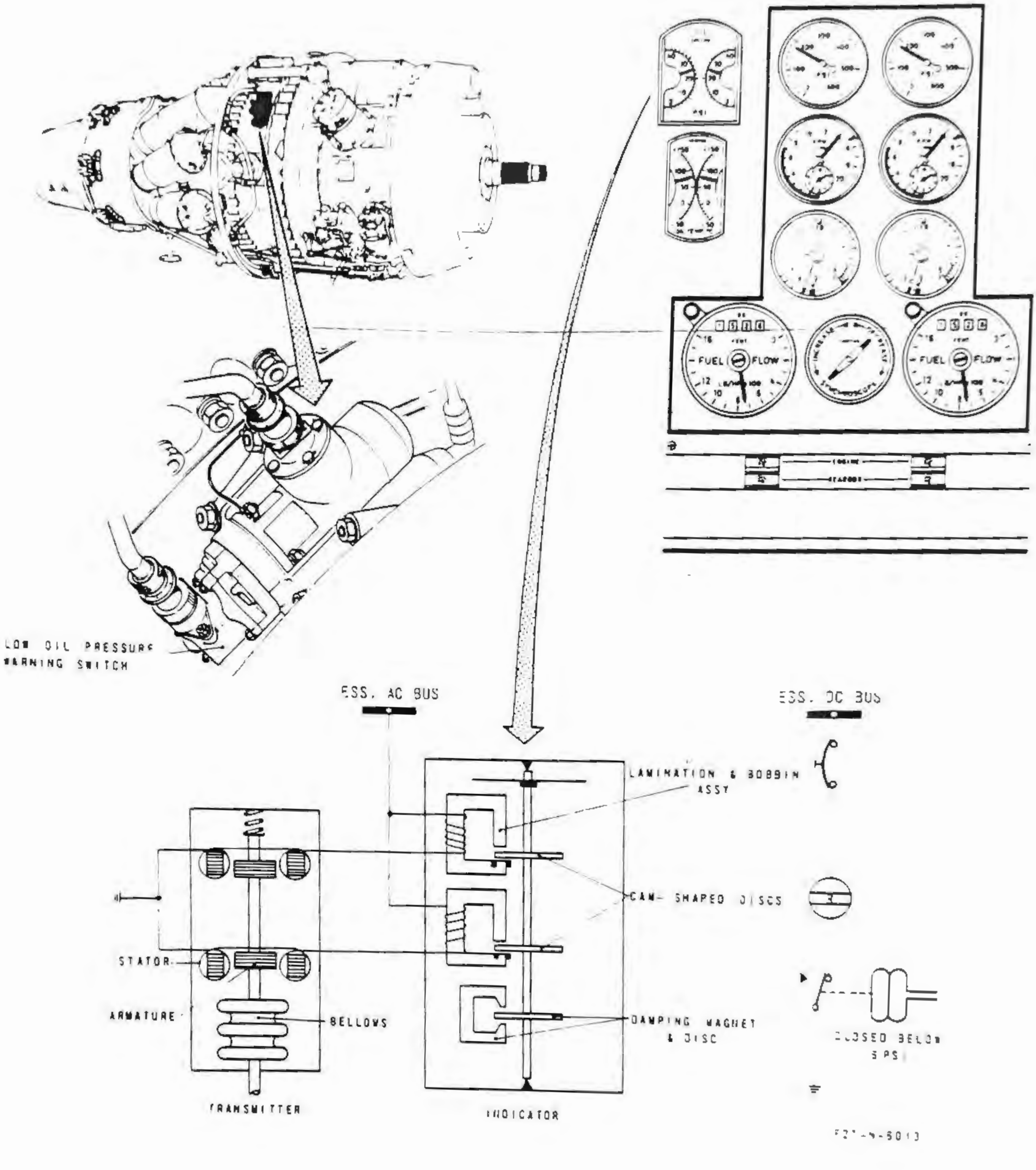
RPM INDICATORS



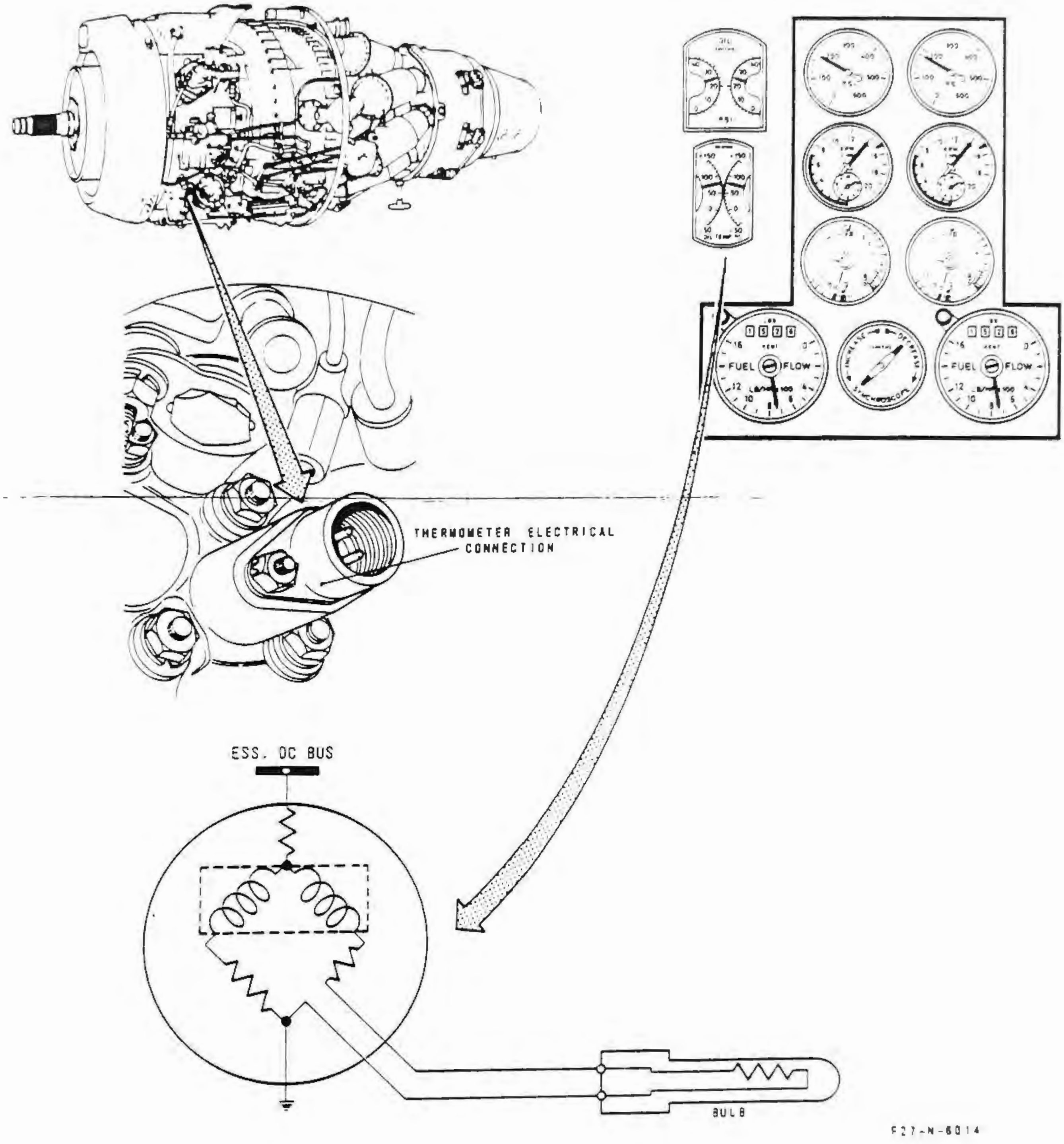
ENGINE SPEED SYNCHROSCOPE



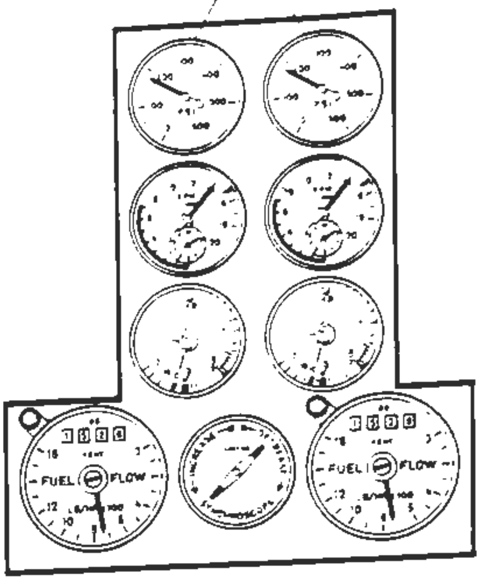
T G T INDICATION SYSTEM

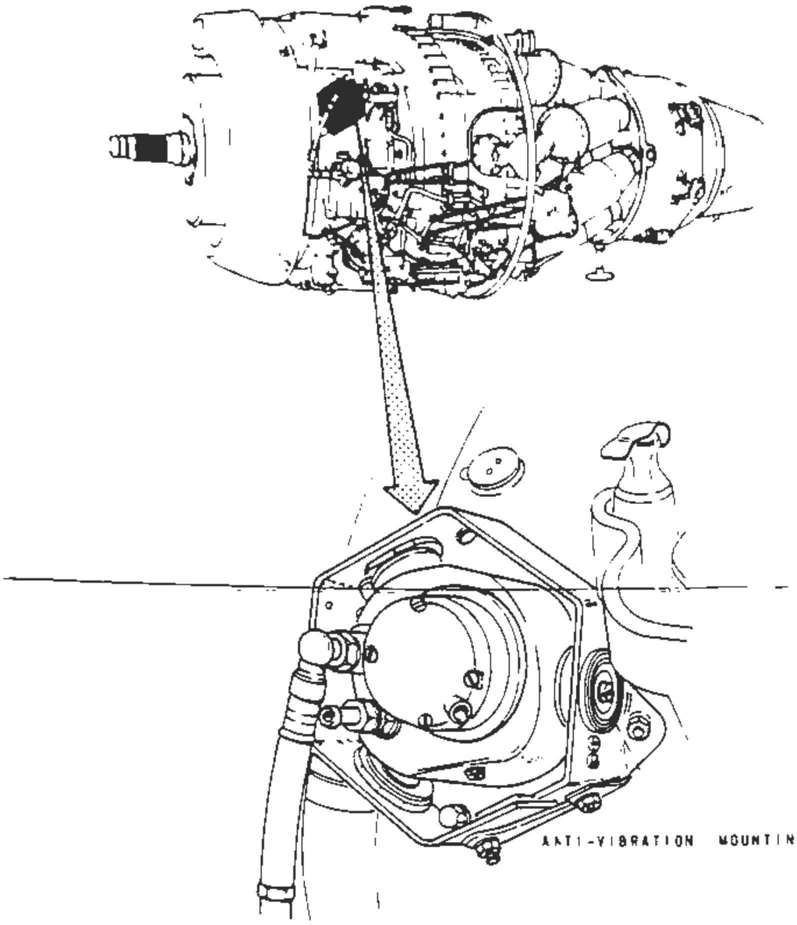


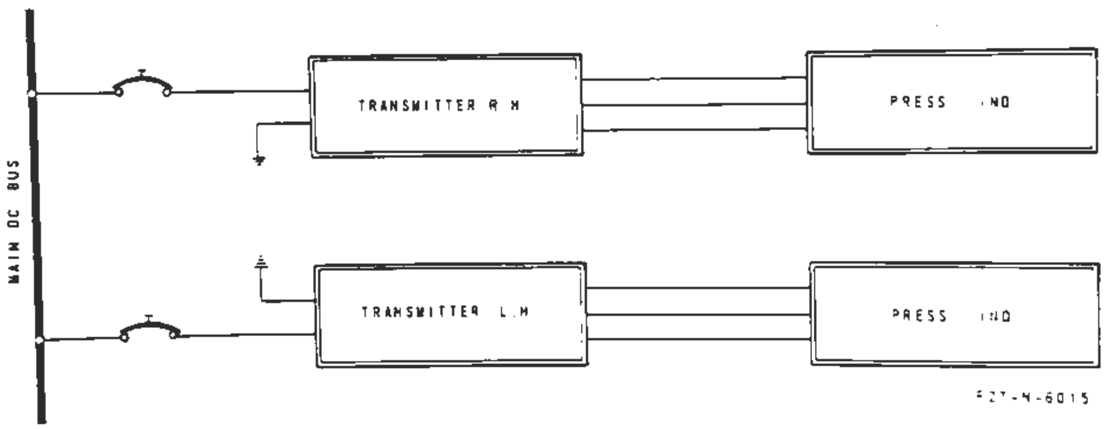
OIL PRESSURE INDICATION WARNING SYSTEM AND LOW OIL PRESSURE



OIL TEMPERATURE INDICATION SYSTEM







TORQUE PRESSURE INDICATION SYSTEM

78. EXHAUST SYSTEM

Engine Exhaust System

This comprises the engine exhaust cone of the "DART" engine the jet pipe assembly and the jet pipe shroud.

The jet pipe shroud assembly is, structurally, a part of the nacelle and comprises steel sheet sections, riveted to the frames of the nacelle between the fire wall and the exhaust opening on the outboard side.

An access panel is fitted to provide access to the jet pipe joint clamp.

Also incorporated in the shroud assembly is a ventilating air duct and a drain tube assembly.

Three flat plate strips and one channel strip are fastened to the inner rear section of the shroud; spaced at 90° intervals.

These act as guide strips for the jet pipe when installed.

Laminated shims may be fitted beneath these when adjustment is required to maintain the clearance of the jet pipe in the shroud area.

The jet pipe is made of seam-welded steel sheet and is in two sections.

The two sections are joined by an expansion joint secured by a clamp ring which is in two halves.

Four fittings, welded to the rear section at 90° intervals, aid in maintaining the jet pipe in its correct position in the shroud by bearing on the guide strips.

Adjustment bolts are mounted on the two inner fittings only.

The front face of the jet pipe has a flange to provide a mounting face for attachment of the jet pipe to the fire wall.

Installation.

Before installing the engine, ensure that the exhaust unit is positioned correctly on the engine. The exhaust unit is mounted with a droop angle of 72 degrees to deflect the gases away from the aircraft. To make the exhaust units interchangeable with each other they are provided with alternative drillings in the mounting lugs. On a left-hand installation, the lugs marked "P" (port) should coincide with the securing bolt on the engine. The lugs marked "S" are for use on a right-hand installation (Refer to R.R. maintenance manual).

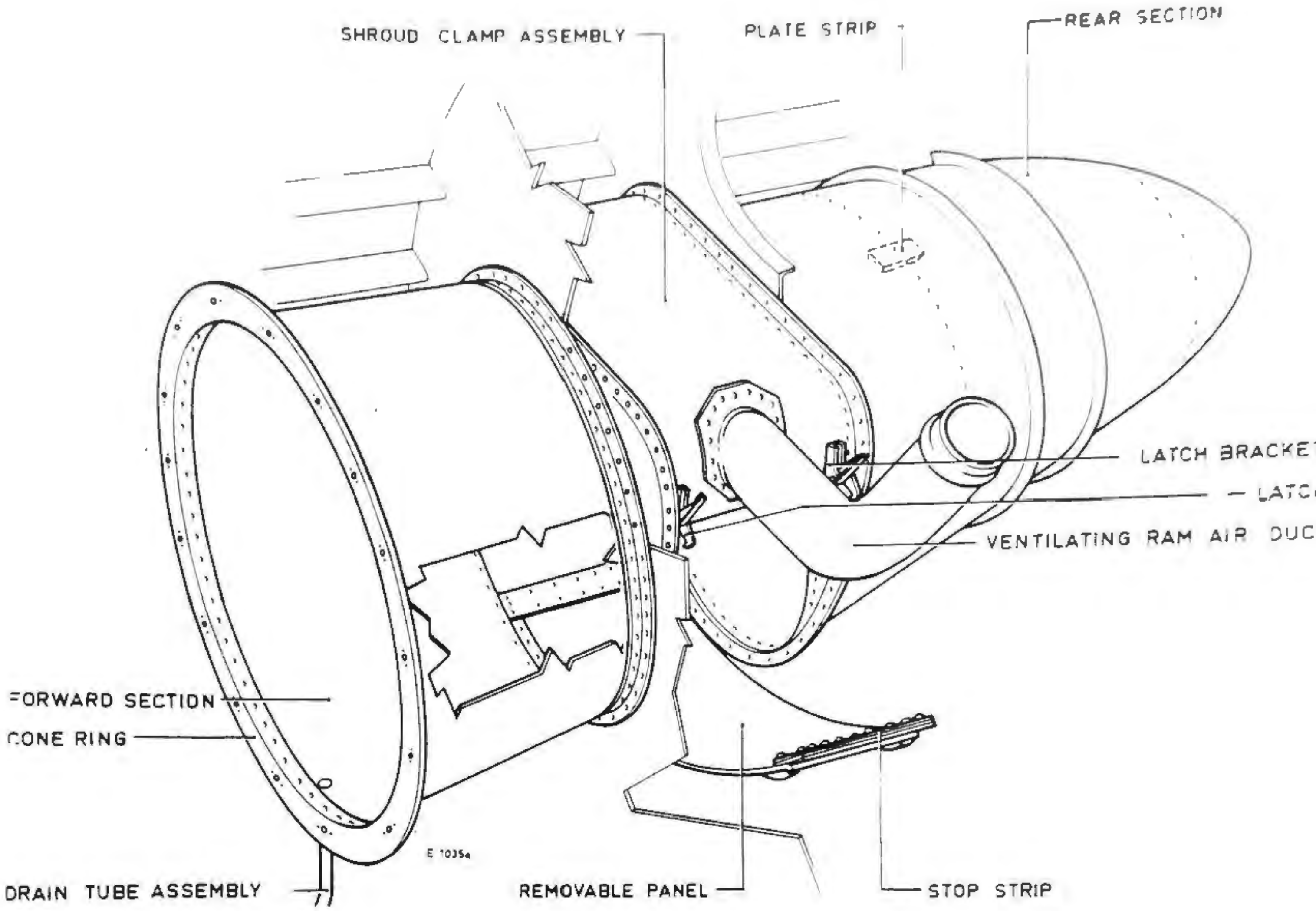
The engine exhaust unit should locate centrally in the jet pipe and the annular gap between the exhaust unit and the jet pipe should be checked at its narrowest point. If the exhaust unit fails to match the jet pipe centrally, check that the spherical collars on the engine mount spigots are firmly seated

When installing the jet pipe rear section a clearance as specified in the Maintenance Manual should be obtained between all four mounting fittings on the jet pipe and the guide strips on the shrouds.

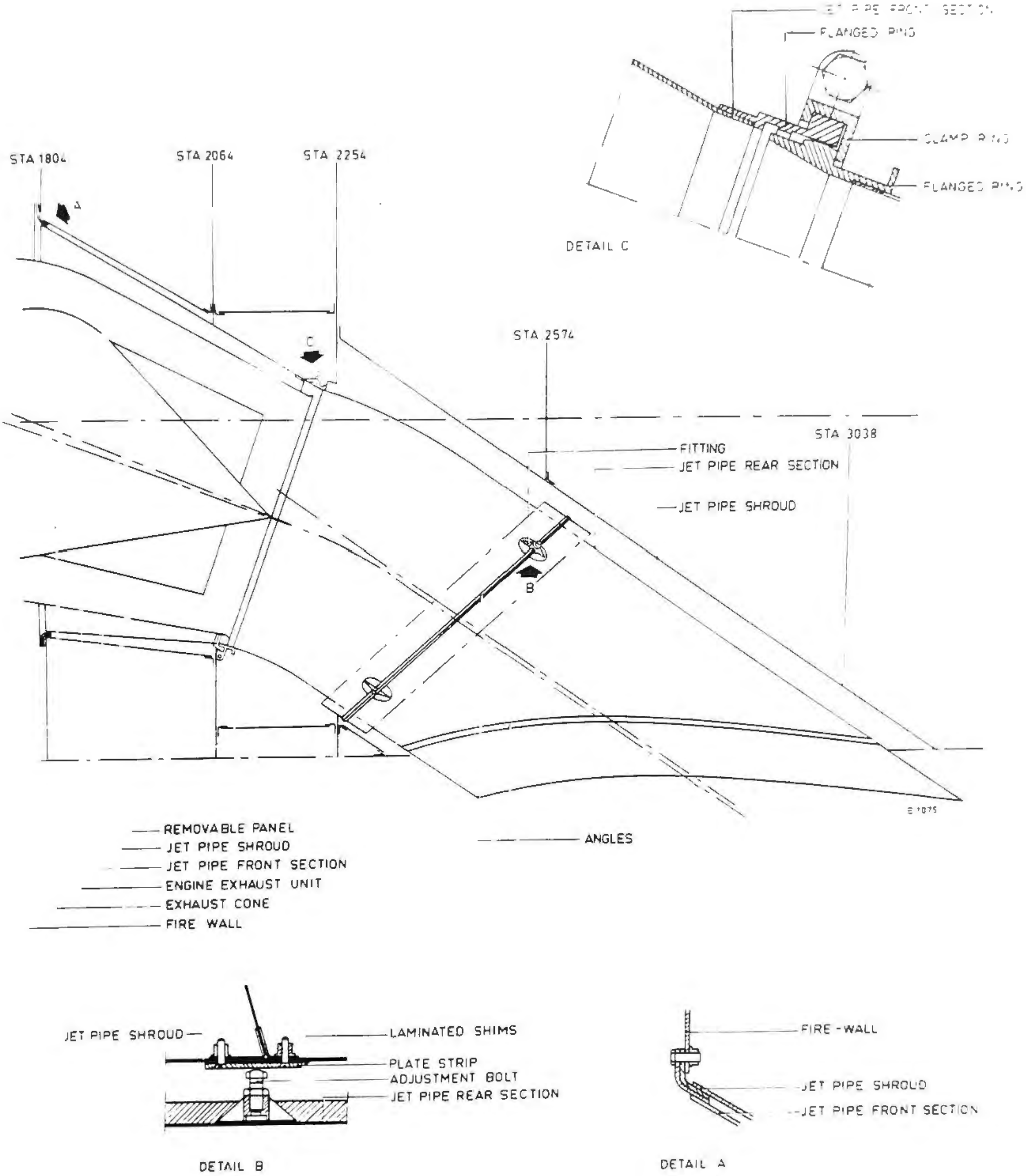
To obtain this adjust the bolts on the two inboard jet pipe fittings or shim the shroud guide strips.

The jet pipe front section can only be removed if the engine is not installed. The rear jet pipe clamp ring is accessible through zone 3 via a removable shroud panel. During removal or installation, the clamp ring has to be rotated to get the diametrically opposite bolt within reach. Keep the clamp ring sections together when the rear jet pipe section is removed as these are machined as a pair.

END



EXHAUST UNIT SHROUD



JET PIPE ASSEMBLY

79. OIL

00.0 GENERAL

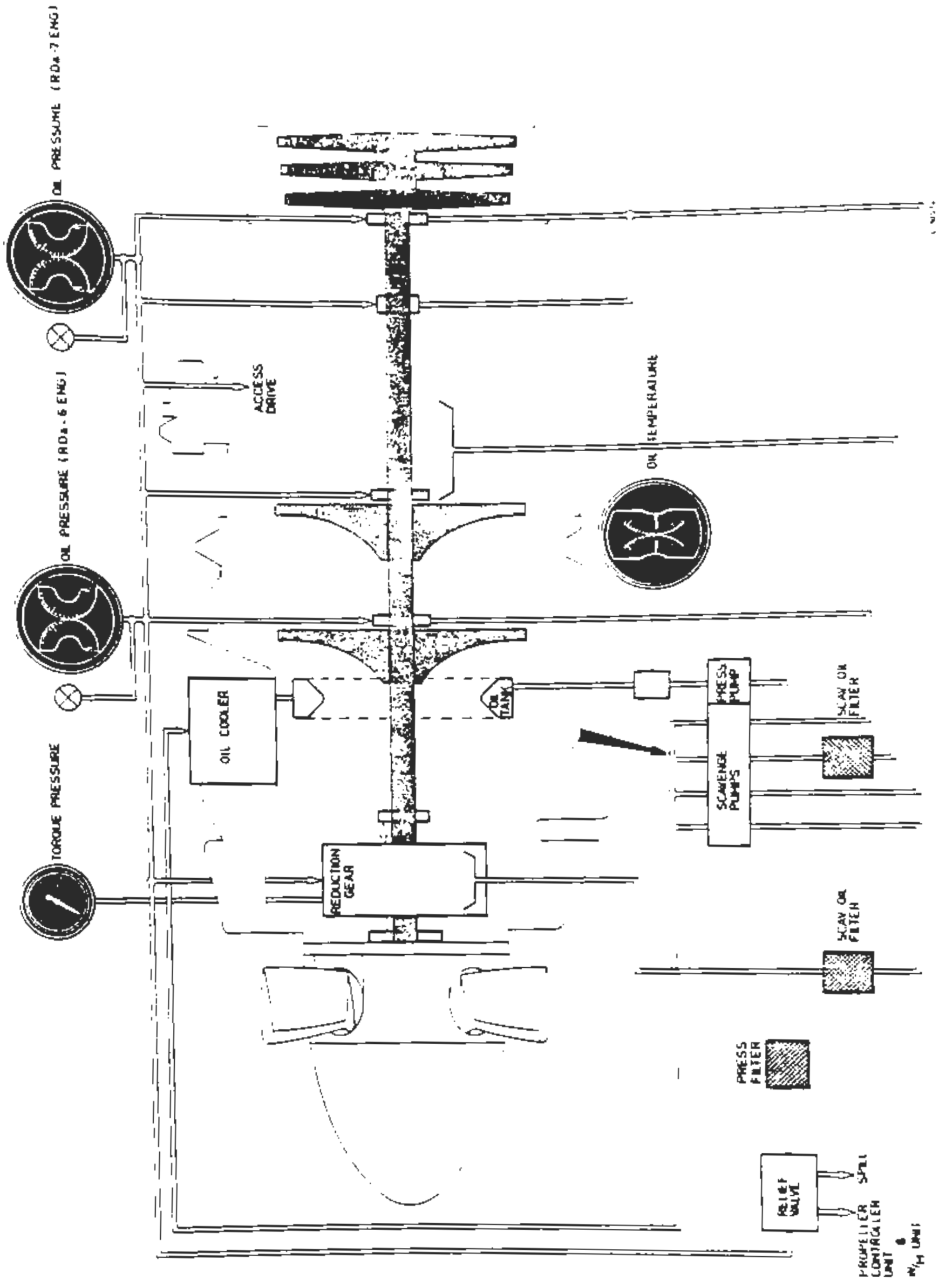
Oil System

The oil system is completely self-contained within the engine and provides jet lubrication for the bearings of the main shaft and reduction gear and an oil flow to the various driving gears and support bearings. It also provides oil for the propeller pitch operation. The system operates on two oil pressures, determined by a dual oil pressure relief valve, consisting of two valves in series each having a relief pressure of 35 psi. The total loading of the valve assembly is therefore 70 psi. The 70 psi oil pressure is taken to the propeller control unit for propeller operation and to the water/methanol unit as a servo pressure, while the 35 psi pressure is used for engine lubrication and also for feeding the torque meter pump.

An oil tank around the rear of the air intake casing holds about 25 Imperial pints. The oil level can be checked via a dipstick which must be done between 10 and 30 minutes after shut-down of the engine.

A centrifugal breather system allows the escape of oil-free air from the oil system through an outlet formed in the accessory gearbox drive gear train. The oil tank, reduction gear and lower drive housing are connected by tubes to allow breathing to occur through the hollow compressor shaft into the accessory drive housing.

END



"DART" ENGINE OIL SYSTEM

STARTING 08

80. ENGINE STARTING AND AIR RELIGHT SYSTEM

00. GENERAL

The starter system is designed to perform four main functions: normal engine start, relight in flight, ignition test and engine blow-out (motor over). For a normal engine start, the starter motor turns the engine drive shaft through a clutch and internal gear train. Air is drawn into the engine by the action of the compressor and is forced into the combustion chambers. Fuel from the burners is mixed with the air and the mixture is ignited by igniter plugs situated in no. 3 and no. 7 combustion chambers. Interconnecting tubes between the combustion chambers ensure complete engine ignition. When the engine is running, the starter motor is disengaged and the electrical circuit automatically de-energized. Provisions are incorporated in the starter system to prevent internal engine damage when the starter button is operated with the engine still turning.
Relight during flight is achieved without the use of the starter motor since the windmilling action of the unfeathered propeller will drive the engine to starting speed. Ignition is provided through a circuit which by-passes the starter motor and is completed by an ignition switch. The relight circuit can also be utilized for ground testing the ignition system. Sometimes it may be necessary to clear the combustion chambers of fuel accumulation. This can be done by energizing the starter motor but isolating the ignition units simultaneously. The starter controls are located on the starter panel.

10.0 CRANKING

10.1 Starter Motor and Transmission

The starter motor is a four pole, compound wound, 28 volt DC motor producing about twelve horsepower. Starting torque is transmitted to the engine through a spring-loaded, multi-plate clutch which protects the starter drive from excessive shock loading. The drive from the clutch is transmitted to the starter engaging mechanism by an inclined shaft and bevel gearing, which provides the speed reduction necessary to enable the starter motor to develop full torque.

10.2 Start and Relight System

For the operation of the start and relight systems, the following controls are provided on the overhead starter panel:

Selector Switch : This switch is labeled LH and RH. The switch is common to both systems permitting starting of either the left-hand or the right-hand engine.

Master Switch : It is labeled START, SAFE and BLOW. In the SAFE position the switch renders the systems inoperative. When set to START the switch arms the systems for normal starting.
When set to BLOW the ignition units are isolated from the starting systems, allowing a motoring cycle to be carried out.

Starter Button : This is a spring-loaded, push button, which completes a circuit between the master switch and the selector relay. On customer's request the switch may be protected from inadvertent operation by a sleeve fitted around the button.

STARTER ON Light	:	This light is on when the selector relay is closed and should be out at a maximum of 30 seconds after depressing the starter button.

The following controls are located on small panels secured to the top of the pedestal and adjacent to the HPC levers and elevator trim wheels:

Ignition switches	:	ON-OFF switches, one for each engine, used to provide ignition during an air relight and for the testing of the ignition systems.
IGNITION lights	:	TWo amber press-to-test lights, one for each engine. Illuminating when the relevant ignition relay is energized.

Relays

The following relays are associated with each start and relight system:

Selector or starter relay	:	Completes the circuit to the starter motor when the starter button is depressed. Both relays are mounted on the centre wing front spar.
Overspeed relay	:	Functions as a speed limiter by tripping the starter circuit when the load on the motor is reduced. One relay serves both systems and is located in the main junction box.
Ignition relay	:	Used in each ignition system and when energized connects DC to the high energy ignition units. Both relays are located in the main junction box.
Time-delay relay	:	Allows sufficient time for the overspeed relay to energize and with the aid of a rectifier in its operating coil circuit, provides a hold-in circuit and renders the starter button inoperative.

Operation

When an external power unit is used to start the engine, the starting system is armed by placing the DC power switch in EXT. POWER, the starter master switch in START and the engine selector switch at the engine to be selected. The circuit to the starter button is completed while the starting system of the other engine is isolated.

If the aircraft batteries are used to start the engine, the starting system is armed by placing the DC power switch in BATT, the starter master switch in START and the engine selector switch at the engine to be selected. The external power relay is energized to supply power to the starting system and the system of the other engine is isolated. By momentarily depressing the starter button, a circuit is completed via the starter master switch, the rectifier and the engine selector switch to the ignition system. At the same moment the time-delay relay and the applicable selector relay will be energized.

The selector relay completes the circuit to the starter motor and the STARTER ON light. Due to the high load current during initial operation of the starter motor the contacts of the overspeed relay will close, ensuring that the selector relay, the time-delay relay and the ignition relay remain

energized when after 50 milliseconds the contacts of the time-delay relay change over. After change over of the time-delay relay, the starter button can be released. When the engine commences to run under its own power, the load on the starter motor will decrease, causing the current to drop. When the current falls to 150 amps the overspeed relay will be de-energized. The overspeed relay contacts will open and interrupt the supply to the selector relay. The selector relay will open and withdraw the supply to the starter motor. Should the starter button be pressed whilst the engine is running, the load on the starter motor will be insufficient to draw the necessary current to operate the overspeed relay. Thus the selector relay and associated starter motor supply will only be available until the time-delay relay changes over after 50 milliseconds. This will prevent any damage to the starter motor.
If the starter master switch is selected to BLOW and the starter button pressed, the starting sequence is performed without ignition. Thus a "dry run" facility is provided. Following a succesful start sequence, the starter master switch is returned to the SAFE position and the ignition and cranking supplies are withdrawn.

10.3 Ignition

The ignition system used in the starting of each engine is straight forward in its layout consisting of two high energy units. Each unit being connected to surface discharge igniter plugs, situated in no. 3 and no. 7 combustion chambers, to produce an instantaneous high intensity spark to ignite the main fuel spray.
When the spray from the burner lights up, the flame spreads rapidly around the engine through the balance pipes interconnecting the combustion chambers. The two high energy units, when operated, are supplied with current from the aircraft 28-volt DC system and to provide a safety factor, the units operate independently of each other and are mounted on access panels in each engine nacelle.

10.4 Not Applicable

10.5 Igniter Plugs

The electrode of turbine engine igniter plugs must be able to accommodate a current of much higher energy than the electrode of conventional spark plugs. Although the higher-energy current causes more rapid igniter electrode erosion than that encountered in reciprocating engine spark plugs, it is not of any consequence because of the relatively short time that a turbine engine ignition system is in operation.
It does, however, constitute the reason for not operating turbine ignition systems any longer than absolutely necessary.

Each plug consists of a centre electrode and an earth electrode separated by a semi-conductor insulator.
The spark or discharge is initiated by a slight electrical leakage across the surface of the insulator, from the centre electrode to earth, providing a low resistance path for the condenser discharge.

10.6 Ignition Test

Testing of an ignition system is accomplished by firstly ensuring that the master switch is in SAFE and then putting the appropriate ignition switch to ON.
Current will then be supplied to the ignition warning light and ignition relay, the energizing of which connects the H.E. units and igniter plugs to the main DC bus-bar.

END

20.0 LIMITATIONS

ENGINE POWER LIMITS

CONDITIONS	RPM	MAXIMUM TGT °C.	
Starting or relighting	-	930	momentary fuel trim max. 85%
Ground idling	7,000 ± 500	550	-
Take-off	15,000 + 50 - 0	940 WET 910 DRY	5 minutes
Other conditions	below / not below 15,000 / 14,000 14,000 / 13,000 13,000 / 10,400 10,400	 800 760 730 550	-
Over speed	17,000	-	20 secs. max.
Excessive TGT	Temperatures up to 1000 °C are permissible provided that the duration in excess of 940 °C does not exceed 5 seconds.		

NOTE: Any instance of the operating limitations being exceeded should be reported and recorded on the engine log.

Avoid continuous ground running below 7,000 rpm, particularly under tail-wind conditions.
Avoid ground running and/or taxying between 13.000 rpm and 13.400 rpm.

LUBRICATION SYSTEM

Oil pressures

Min. acceptance at 12,000 rpm	13.5 psi at oil temp. below 55 °C. 13.5 to 12 psi at oil temp. between 55 °C and 120 °C.

Oil temperatures

Min. for starting	- 30 °C.
Min. for opening up	- 15 °C.
Min. for wet TO power	+ 50 °C.
Maximum	+ 120 °C.

FUEL SYSTEM LIMITATIONS

Asymmetric fuel load

The maximum permissible asymmetric fuel load, during flight, between the wing tanks is 1,100 lb (135 Imp. Gall. or 162 U.S. Gall.)

If the fuel pump governor has been set for the use of wide-cut, it must be reset when the fuel is changed to kerosine (higher specific gravity) and vice versa.

WATER/METHANOL SYSTEM

No W/M selection	Above 14,500 rpm (except in emergency). Below -30 °C. amb. temp.
Use of W/M restricted for T/O	Above ISA + 35 °C amb. temp. up to 10.000 ft

PROPELLER LIMITATIONS

The feathering units must not be operated for more than 3 minutes per hour.

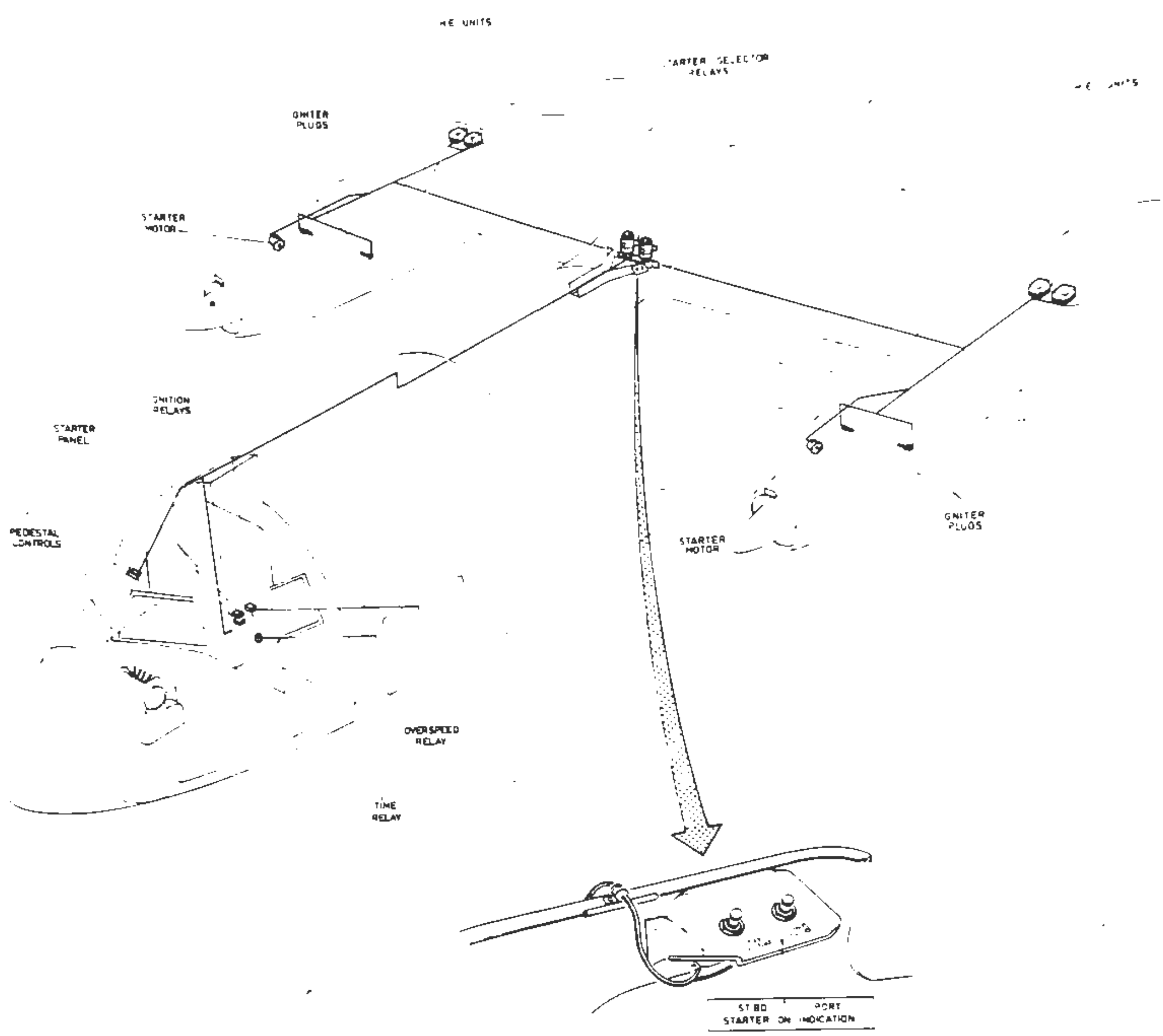
INTERNAL BATTERY STARTING

OAT	Above - 10 °C
Battery voltage	24 V min.

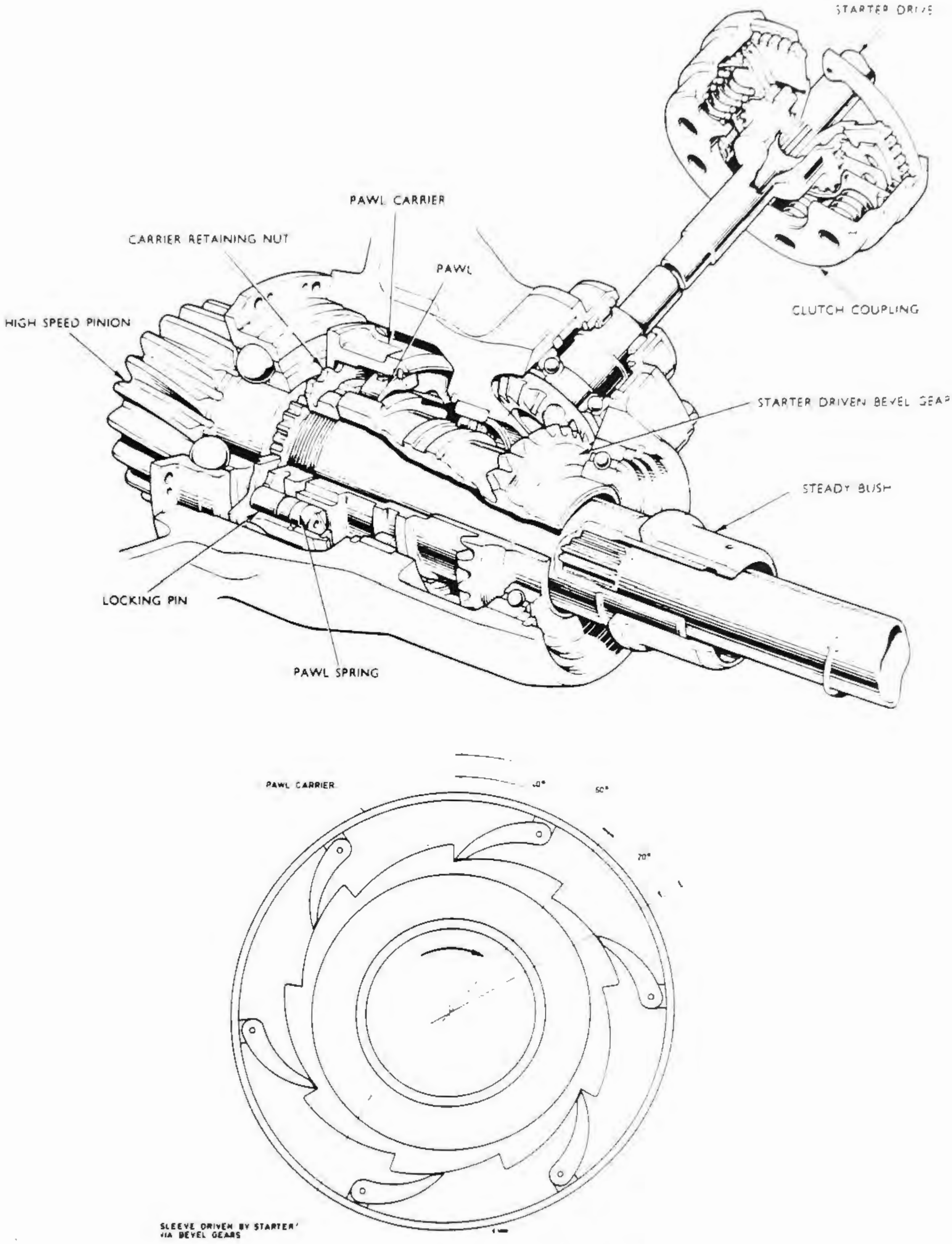
STARTER MOTOR

Max. for continuous operation:	30 seconds.
Max. number of consecutive starting and/or "motoring over" cycles: - on ext. power	6
- on batteries	4
Min. waiting period after 6 consecutive starting and/or "motoring over" cycles:	15 minutes.

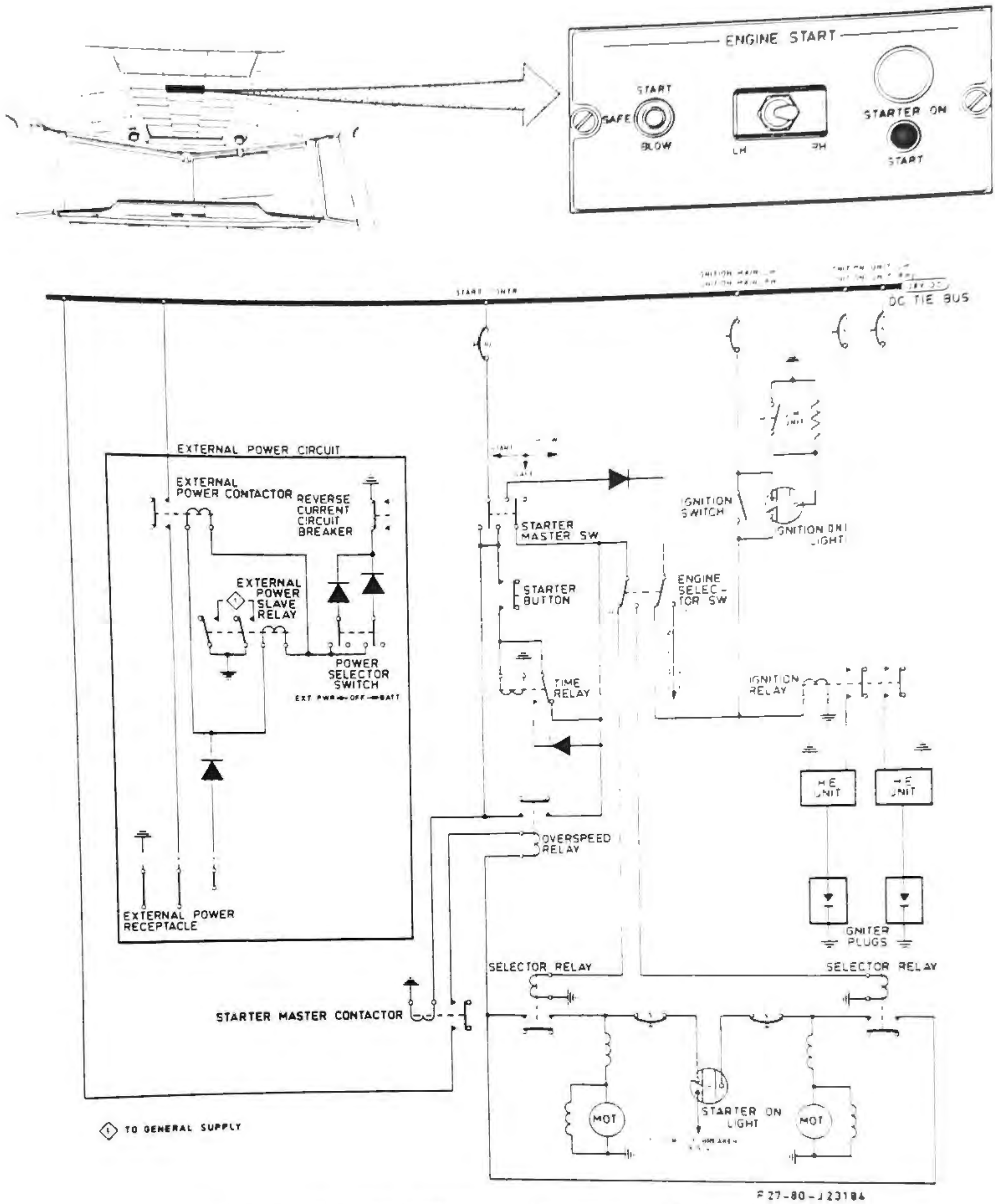
END



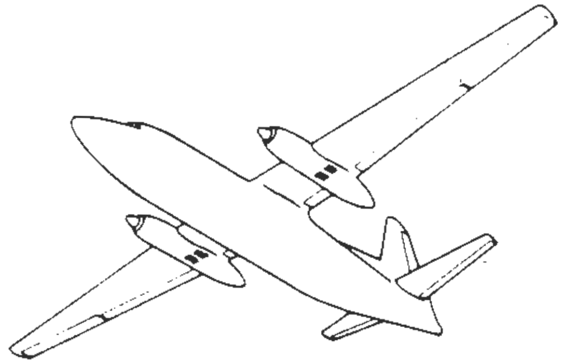
ENGINE STARTER SYSTEM - LOCATION OF COMPONENTS

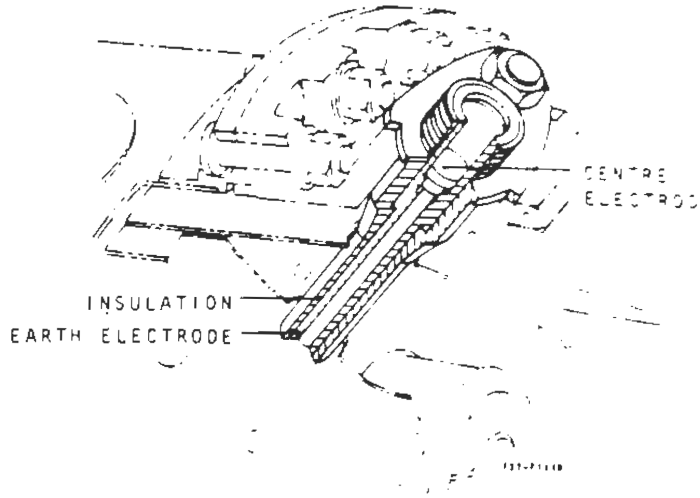


STARTER ENGAGING MECHANISM

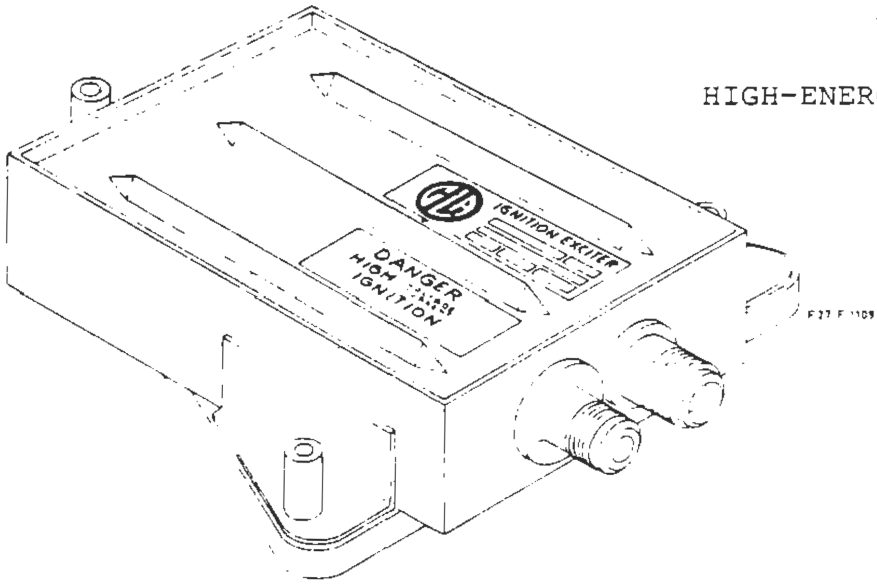


ENGINE STARTER SYSTEM - THEORETICAL DIAGRAM

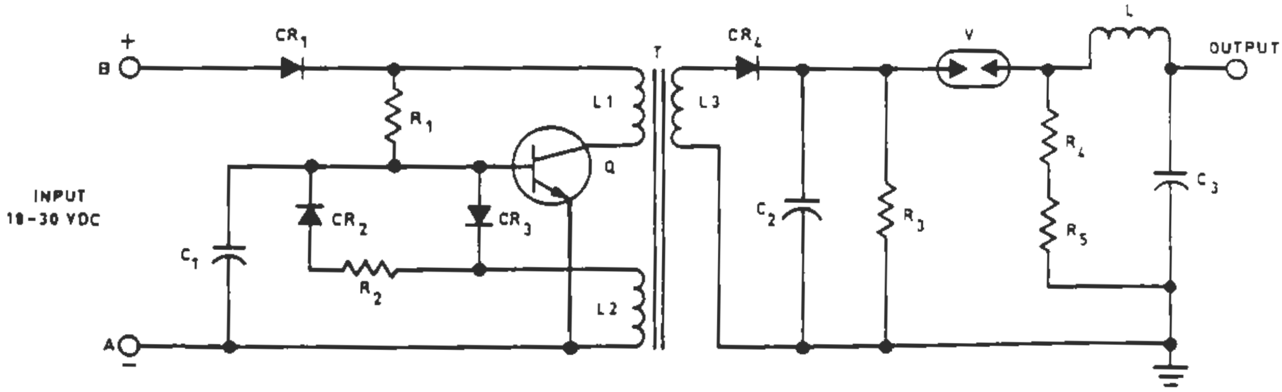




HIGH-ENERGY IGNITER PLUG



HIGH-ENERGY IGNITION UNIT



HIGH-ENERGY IGNITION SYSTEM COMPONENTS

81. MAINTENANCE NOTES POWER PLANT

00.1 Ram Air Pressure Sensing Line

At the recommended inspection periods the ram air pressure sensing line connected between the FCU and the air intake casing should be checked that the line is free from obstruction and water.

Disconnect the hose clips securing the flexible hoses on the ends of the line at the top of the FCU and at the air intake, and apply a compressed air supply to the ram air pressure connection and check that the drain hole is free from obstruction.

00.2 Overspeed Governor Check

A check of the overspeed governor should be carried out after engine installation, after fuel pump replacement at the recommended inspection and when investigating a defect.

The following is a summary of the procedure for checking and setting the governor:

- Disconnect the rpm control rod from cross-shaft lever.
- Wire the rpm lever against the max. rpm stop.
- Trip the auto-feathering circuitbreaker.
- HPC lever - lock-out.
- Fit the setting jig on to the engine, and adjust the adjustment screw (see M.M. Rolls Royce).
- Run engine and check that the speed is governed at 14.700 rpm.

00.3 Engine Ground Run

An "Engine Serviceability Ground Run" should be carried out on each of the following occasions:

- After installing an engine.
- After changing a component which could affect engine performance.
- After a propeller change.
- After any engine control adjustment.
- After compressor cleaning has been carried out.

The ground run should be carried out in accordance with the applicable Rolls-Royce Manual.

00.4 Turbine Gas Temperature Indication

Thermocouple Harness Resistance and Insulation check.

The thermocouple harness should be checked for resistance and insulation at prescribed periods, and prior to running an engine after installation of a new harness, thermocouples, or parts of the wiring system.

The complete circuit should be checked as follows:

- Check harness in accordance with the applicable Rolls-Royce Manual.
- Disconnect leads at indicator.
- With a resistance measuring bridge, check that resistance is within 8 $\pm$ 0,15 Ohm or 25 $\pm$ 0,15 Ohm dependent on the type of indicator.
- With a 250 volt megger check the insulation resistance between the leads in the cockpit and ground connection.

00.5 Fuel Trim Control System Check

The position indicator calibration should be checked periodically. There are two methods of checking the calibration. A routine check which must be carried out whenever a trimmer actuator has been replaced, and a more detailed check requiring the use of a degree plate attached to the throttle valve lever. The more detailed check must be carried out after engine installation and after replacement of a fuel flow control unit, a fuel datum indicator or its transmitter.
For full information reference is to be made to the applicable Rolls-Royce Maintenance Manual.

END